

BEST TECH OF THE **YEAR**

POPULAR SCIENCE

TODAY'S

100

**GREATEST
INNOVATIONS**

DRONES, PHONES,
DRIVERLESS CARS,
VIRTUAL REALITY,
A HOVERBIKE,
AND **MORE!**



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FEATURING:

**STAR WARS
DROID**

BB-8

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EMOJI
LANGUAGE OF THE
FUTURE P.10

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DECEMBER 2015 • **FEED**

Volume 287 No. 6

28TH ANNUAL BEST OF WHAT'S NEW 2015



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BB-8 from *Star Wars: The Force Awakens*, courtesy of LucasFilm Ltd.



THE 100 GREATEST
INNOVATIONS OF THE YEAR

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BEHIND THE SCENES WITH BB-8

How the animatronics team from *Star Wars: The Force Awakens* built a new robot icon (and why you'll love it).

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Devices can now measure your every move and breath—and even those habits you would rather keep hidden.

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FEED • DECEMBER 2015

From the Editor

Redefining Possible

Of all the movies to come out this year, none has been more highly anticipated by the editors at *Popular Science* than *Star Wars: The Force Awakens*. Seems like every day I hear someone talking about it. The other morning I arrived in the office only to find our photo director, Thom Payne, flying a Millennium Falcon drone over everyone's desks. Somebody else

had a drone X-wing (which, for the record, flies like a rock). I know we're putty in some Disney marketer's hands—and I'm OK with that.

As we sit around and obsess over all things *Star Wars*—Harrison Ford for the win!—one topic keeps coming up: the return to practical effects. In the age of green screens and CGI everything, director J.J. Abrams made a considered decision to film as much real stuff as he could—a challenge when re-creating a galaxy far, far away, and a contrast to the three CGI-laden prequels of the late 1990s and early 2000s.

Perhaps the best example of this is BB-8, the lovable ball droid that captured imaginations when the film's trailer popped in July. Instead of opting for a 3-D animation that he could insert at key moments, Abrams tasked his team with creating the actual droid. Or seven versions of it, as the case may be. In "How to Create a Robot Icon" on page 24, creature-effects designers Matt Denton and Josh Lee pull back the curtain on one of the film's more closely guarded backstories.

Just as the willingness to redefine what's possible is a hallmark of Abrams' approach to *The Force Awakens*, it's also the theme of our annual Best of What's New awards. For the past 28 years, we've dedicated our December issue to the 100 greatest innovations of the year.



“
EVERY BEST OF
WHAT'S NEW AWARDEE
REPRESENTS A
BREAKTHROUGH,
SOMETHING THAT HAS
NEVER BEEN DONE.”

BB-8 certainly qualifies—the robot-toy company Sphero came out with a miniature version of it for your living room—but we also honored a vaccine that can eradicate an epidemic, a genetically modified rice that can alleviate climate change, and a drone that can follow you around like a dog, among many others. Our Innovation of the Year, the HTC Vive, is the first virtual-reality headset that allows users to interact with the digital world around them. Want to pick up a virtual plate and throw it at a virtual wall? Go for it.

Our Best of What's New awardees are a diverse group, but they share a common thread. Every one of them represents a breakthrough, something that has never been done before. And every one of them will leave our future that much brighter. So dive in to our list of 100. I think you'll find that 2015 is a year to remember.

Enjoy the issue.

Cliff Ransom
Editor in Chief

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The exceptional **Sigma 50mm f/1.4 DG HSM | A** is a member of the acclaimed Sigma Art Line, an elite collection of lenses created especially for sophisticated photographers who demand the ultimate in image quality along with expanded opportunities for artistic expression. Technically it's a classic high-speed normal lens for full-frame DSLRs, providing a natural viewing angle similar to the human eye, with a very wide maximum aperture for enhanced low-light performance and creative control. But this extraordinary lens goes far beyond normal in what it can capture in the hands of an inspired photographer.

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Peer Review



Coffee vs. Tea: The Reader Showdown

To answer “Does Coffee Give You a Different Buzz Than Tea?” [Ask Anything, October 2015], we consulted a nutritional psychologist. Her answer: The buzz is indeed different, depending in part on a person's genetics. Our Facebook followers seem to agree.

Tea definitely has a more stimulating effect for me.

Carl Hansen

I've started drinking tea again after a couple of years of exclusively coffee and, I must say, tea makes me feel better. I don't feel wired, but I also don't feel as tired as I would be without caffeine either.

Molly Doherty

Tea makes me yawn. One large Turkish-

Greek-style coffee is an essential part of re-entry to the world.

Gav Ritchie

Chai tea is the best! I drink it every day before work, and the little bit of caffeine in it keeps me going way longer than coffee drinkers.

Joseph Miskowitz

Here in the Middle East, tea is preferred over coffee, but they both have the same effect on me.

Genesis Calamiong

Coffee for waking up; Earl Grey tea for going to sleep.

Taylor Gillispie

TWEET OUT OF CONTEXT

Those wild boars have 5 legs each @WillemBruce

Pass the Salt

For years I've called the concept described in “Food Without Food” [October 2015] as “Dog Food for Humans.” My dog eats pretty much the same thing every day and stays healthy and active—well, for an animal that sleeps 18 hours a day. Why can't there be food like that for people? Boring? Yes. But easy? Very.

Mike Bitondo

Pinckney, Michigan

The Great Blender Hack

Many thanks for featuring the Electrolux blender and its incredibly effective engineering changes [“Angling for a Perfect Blend,” October 2015]. My thrifty Scot nature, however, loves my chrome Oster blender, which I purchased for \$17 in 1963. So, using the same idea, I slowed the blades and tilted the whole thing for about 30 to 45 seconds. Wow, I got the same results with visible seeds, a smooth-as-silk texture, and no grit.

Donna McIntosh

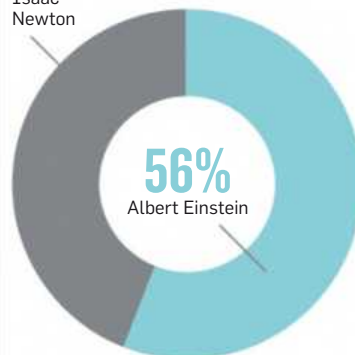
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HAVE A COMMENT?

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44%
Isaac
Newton



RELATIVITY IT IS

Last month we asked you to pick your favorite scientist: Albert Einstein or Isaac Newton? The numbers skewed Einstein, but the comments were largely Newtonian.

No question, Newton. He derived new mathematics to prove his theory. Einstein created no new mathematics and had to be tutored by his superiors often.

Victor Mascolo

Einstein went out with a bang, but it's the details—that matter, and Newton has those.

Anis Haris

Nikola Tesla
Barry Lynn Colbaugh

BEST OF THE REST

Starting on page 19, we describe the 100 best innovations this year. But that's just our take. What would you call the best? Tweet your answer (and reason) to [@popsci](#) #BOWN.



One contender: the Generac IQ2000 smart generator

A Bit About Us

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In September, *Popular Science* attended World Maker Faire in New York City. Among our favorite projects:



The Lumiphonic Creature Choir, which has 12 disembodied heads controlled by a keyboard



A fire-breathing 30-foot-tall robot made from discarded airplane parts



Fortunetron 7000, an automated fortune-teller that pulls your fate from the Internet



PlasmaBot, a marionette made of glass and filled with glowing plasma

See them in action at www.popsci.com/makerfaire.



In an office not that far away...

Popular Science is in full *Star Wars* mode. Not only do we have BB-8 rolling in and out of cubicles, but we're also racing the remote-controlled *Millennium Falcon* and X-wing Starfighter made by Airhogs. The *Millennium Falcon* flew like a dream from the start. The X-wing, not so much. (Some editors needed to duck.)

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NEW

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Contract**

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"Cell phones have gotten so small, I can barely dial mine." Not Jitterbug®, it features a larger keypad for easier dialing. It even has an oversized display so you can actually see it.

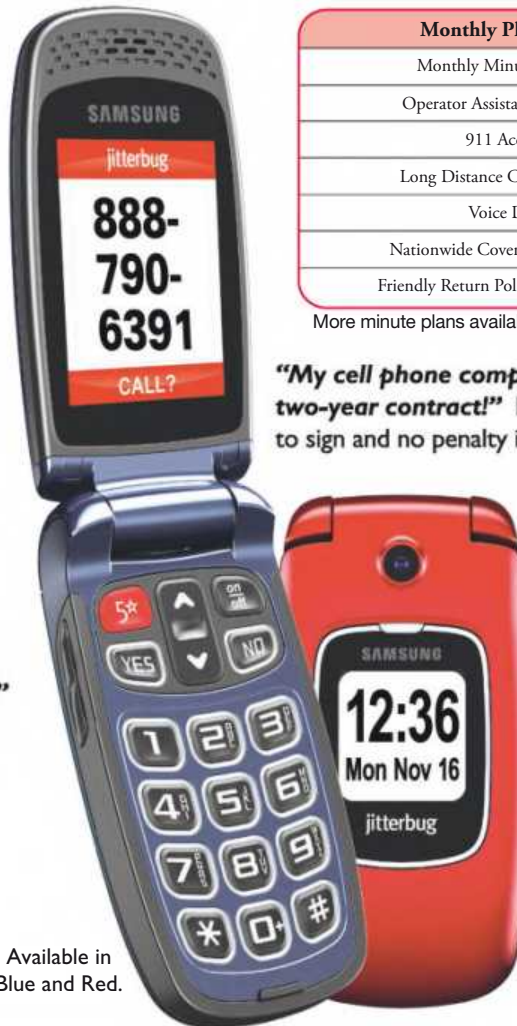
"I had to get my son to program it." Your Jitterbug set-up process is simple. We'll even pre-program it with your favorite numbers.

"I tried my sister's cell phone... I couldn't hear it." Jitterbug is designed with an improved speaker. There's an adjustable volume control, and Jitterbug is hearing-aid compatible.

"I don't need stock quotes, Internet sites or games on my phone, I just want to talk with my family and friends." Life is complicated enough... Jitterbug is simple.

"What if I don't remember a number?" Friendly, helpful Jitterbug operators are available 24 hours a day and will even greet you by name when you call.

"I'd like a cell phone to use in an emergency, but I don't want a high monthly bill." Jitterbug has a plan to fit your needs... and your budget.



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Long Distance Calls	No add'l charge	No add'l charge
Voice Dial	FREE	FREE
Nationwide Coverage	YES	YES
Friendly Return Policy¹	30 days	30 days

More minute plans available. Ask your Jitterbug expert for details.

"My cell phone company wants to lock me in on a two-year contract!" Not Jitterbug, there's no contract to sign and no penalty if you discontinue your service.

"I'll be paying for minutes I'll never use!" Not with Jitterbug, unused minutes carry over to the next month, there's no roaming fee and no additional charge for long distance.

"My phone's battery only lasts a couple of days." The Jitterbug's battery lasts for up to 25 days on standby.

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EDITED BY *Breanna Draxler & Matt Giles*



The IceCube telescope sits inside a cubic kilometer of ice a mile beneath the South Pole. Its 5,000-plus light sensors detect subatomic particles called neutrinos—100,000 of them a year. This summer, researchers found neutrinos that pulsed with 1,000 times the energy of the world's most powerful particle accelerator. Such particles can only come from beyond our solar system, says Francis Halzen, a physicist at the University of Wisconsin at Madison and IceCube's principal investigator. The discovery could provide a better understanding of black holes and exploding stars, which are thought to have launched the neutrinos. "We had no guarantee these cosmic neutrinos would exist," says Halzen. "It reveals a new way to study the sky." **STEPH YIN**

400,000

Number of Olympic-size pools the ice block could fill

John McWhorter

On the Future of Language



Over time, languages naturally change. In the past, cultural collisions caused by slavery, exploration, and war have pushed them even further, says Columbia University linguist John McWhorter. Today, new forces are at play. Languages are transformed by technological advances that transcend borders and redefine how we communicate—and with whom.



“

Today there are six or seven thousand languages worldwide. Over the course of the next century, there are going to be only about six or seven hundred. The more-common languages will eat up the ones that are geographically isolated or spoken by only a few people.

Technology and globalization play a big role in this shake-up. The amount of media that we can listen to and watch nowadays was unthinkable 50 years ago.

Increasingly, instead of attempting to learn foreign languages from guidebooks or asking strangers for help, we'll use instant-translation apps. We'll talk into devices that spit out translations to listeners. But technology goes only so far. People will want to communicate more spontaneously than any machine is ever going to be capable of.

820

Number of
living languages
in Papua
New Guinea,
the most of
any country

“English is not going to eat up all the world's languages, but it will have the status of *lingua franca*.”

When we do converse, the universal language won't be an artificial one like Esperanto. And it won't be Chinese. It's going to be this weird language that originated from tribes drinking blood out of skulls somewhere in Denmark a very long time ago. That's what we're speaking now. The Chinese will be running the world, but they'll be doing it in English, simply because English “called it.” It got there first and circled the globe with the Internet.

English already infiltrates texting with shorthand like “LOL.” And that

brings up another point: Simplified versions of language are inevitably going to arise on smartphones. You're tempted to leave out a lot when you're writing with your thumbs. I think emoji, with those cute little faces, are fun. They make the way people write with their fingers richer.

In the future, language is going to be less formal—more loose-limbed and creative. That's not necessarily a bad thing. All language changes all the time, like in a game of telephone. It can't help it.

—AS TOLD TO BREANNA DRAXLER

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Insane Study



THE END OF THE BIG DRIP

↓
Too busy chasing drips to enjoy your ice cream? In August, two U.K. universities announced they'd come up with a fix, with a little help from bacteria. **LYDIA CHAIN**

Origins

Certain kinds of bacteria shield themselves from the attacks of other microbes by producing a biofilm—a water-repellent layer that acts like a microbial raincoat. Researchers isolated a protein responsible for biofilms, BslA, from *Bacillus subtilis*, a bacteria found in dirt.

Execution

When ice cream warms, the fat and sugar separate (like oil and vinegar). This causes trapped air bubbles to escape and ice crystals to melt. When scientists added BslA to ice cream, the fat and sugar remained mixed, so the matrix of ice and air stayed in place longer. The ice cream scooped normally but dripped more slowly as it warmed.

Future

No word on palatability yet. "I keep fighting the people in my lab to let me taste it, but so far I haven't," says biomolecular physicist Cait MacPhee. Though BslA is safe to eat—*Bacillus subtilis* is used to make natto, a fermented soybean dish in Japan—scientists are still performing tests. If the process can be ramped up to an industrial scale, slow-drip ice cream could reach the freezer aisle in as few as three years.

JONATHAN KAMBOURIS/GALLERY STOCK

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How to Brew a Better Painkiller

“The way we produce these chemicals is so outdated. Synthetic biology is dragging the field into the future.”

—CHRISTINA SMOLKE, BIOENGINEER AT STANFORD UNIVERSITY



This past August, Stanford bioengineer Christina Smolke announced a first: Her team used brewer's yeast—the stuff in beer—to produce a precursor to oxycodone and the active ingredient in Vicodin, two of the world's most popular painkillers. By splicing 23 genes from plants, animals, and microbes into yeast DNA, she says, “We created a chemical assembly line.”

Predictably, the achievement caused a stir. On the one hand, it was a significant breakthrough. Opiates are useful and highly sought-after painkillers. Yet their manufacture still begins with physically scraping sap from the seedpods of opium poppies. That makes them expensive and limited. Smolke's method breaks that process open in a big way.

On the other hand, democratizing drug manufacture sounds scary. “People are trying to figure

5.5

Number of people worldwide, in billions, without access to painkillers, according to a United Nations report

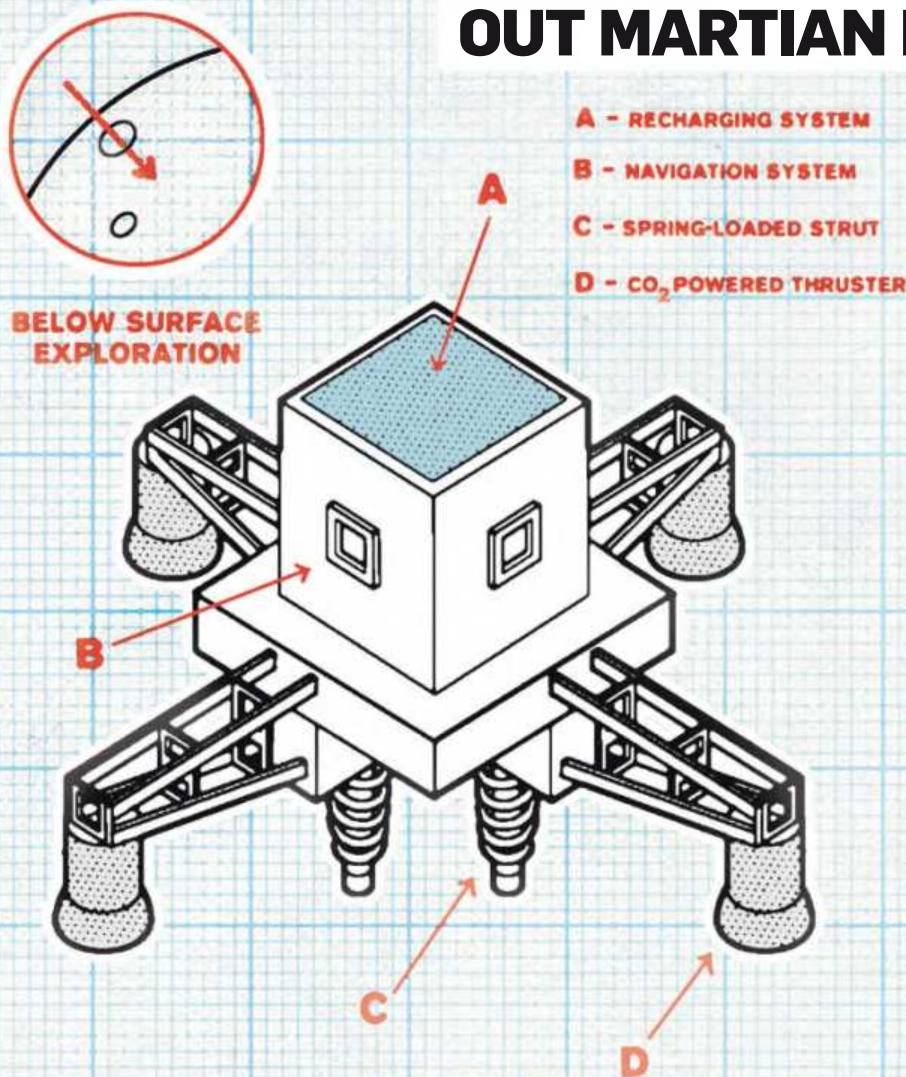
out potential abuses of this powerful technology,” says Kenneth Oye, a political scientist at MIT. “It is hard to put stuff back in bottles after the fact.” In theory, once Smolke refines the process, anyone with an undergraduate biology degree could start an underground dope lab. Picture *Breaking Bad* but with yeast. Drug agencies, Oye says, are not remotely prepared to handle a flood of synthetic opiates.

The truth is, they don't have to worry for some time. In its current form, Smolke's yeast is still proof-of-principle. The yield is so low that you'd need 4,400 gallons of it to make a single Vicodin pill. That said, the process will become more efficient, as every process does, and when that happens some regulation needs to be in place. “We don't want to get caught flat-footed and suffer a moratorium on exciting research,” says John Dueber, a

synthetic biologist at the University of California at Berkeley.

In the meantime, scientists will continue to coax painkillers and other drugs from yeast. Synthetic biologists already have a target list of thousands. They will also try to improve and customize the drugs we have. By modifying yeast, scientists could in theory use it to produce less-addictive painkillers, resistance-proof antibiotics, and even drugs to combat cancer. “Plants have never made the ideal medicine; humans just adapted them,” Smolke says. “Now we can go beyond that to build better medicines.” **MATT GILES**

DRONES TO SCOPE OUT MARTIAN REAL ESTATE



HIGH-SPEED AUTONOMY

Programming a robot to fly itself through unexplored caverns is daunting enough, but Astrobotic's navigation and perception algorithms need it to "think" at 20 mph. That requires the drone to have a largely unprecedented degree of decision-making without any human input.

AERIAL MOBILITY

The Martian atmosphere is 100 times thinner than Earth's, making rotors ineffective. Researchers are instead exploring CO₂-powered thrusters, which would enable a drone to make the sharp turns necessary in unmapped tunnels.

RECHARGING SYSTEM

When the vehicle's thrusters run out of pressurized CO₂, it could land and use an onboard isotope generator (or solar panels if it's outside the caves) to power a compressor that pulls fuel from the atmosphere.

GROUND GAME

The drone could catapult through Mars' low gravity (about 38 percent of Earth's) using a spring-loaded strut. Hopping would allow it to cover terrain too rough for wheels or treads, without consuming as much fuel as flight.

ROVING BASE CAMP

Astrobotic plans to have rovers that act as rolling motherships for planetary drones—storing them during long treks, launching them at the mouth of promising caves, and transmitting the data they collect back to NASA.

In October, NASA released its plan for getting to Mars. The trip is a long way off (we're talking decades), but the agency says it's gearing up: "Like the Apollo Program, we embark on this journey for all humanity. Unlike Apollo, we will be going to stay." Easier said than done. Aside from the unbreathable atmosphere and wonky gravity, the radiation on Mars could cause brain damage, cancer, and death.

Our best bet for survival may be to hunker down in the protection of lava tubes—networks of tunnels created billions of years ago by molten rock. We can't send rovers in for recon though. The pits can be 100 meters deep, and the thick walls (and lag time) make real-time radio communication impossible.

Carnegie Mellon University, along with a spinoff called Astrobotic Technology, has set its sights on a more effective scout: an autonomous drone. The team recently won a \$125,000 contract from NASA to develop the software. Eventually, they plan to build a robot that can fly and hop through steep passages.

"Safe haven is a huge priority, right from the beginning," says William "Red" Whittaker, founder and chief science officer of Astrobotic. "And out of that diversity of caves, there are likely to be underground spaces that are incredibly amenable to habitation." **ERIK SOFGE**

"We haven't even begun to look at the immense variety of landscapes in the sub-Martian world."

William "Red" Whittaker, director of the Field Robotics Center at CMU

POPULAR SCIENCE

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REASON
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THE FIGHT FOR THE FASTEST SUPERCOMPUTER

In 2015, China claimed the record for the world's most powerful supercomputer—for the third year in a row. The Tianhe-2 crushed the U.S.'s Titan in the esteemed TOP500 supercomputer ranking. And that from a country with only 7 percent of the world's supercomputers (compared with the U.S.'s 46 percent). Computing power translates into economic power and national security, so

falling behind should come as a wake-up call. This should be our "Sputnik moment."

As with the rush to orbit, "this is an international race," says Horst Simon, deputy director at Lawrence Berkeley National Laboratory and co-editor of the TOP500. The next mile marker will be achieving "exascale" computation, which means performing 1 quintillion calculations per second (about 30 times faster than Tianhe-2). Whoever gets there first could revolutionize weather forecasting, design hyperefficient airliners, and fight disease with precision medicine—not to mention corner the market for computing power.

The U.S. was once the undisputed front-runner, but since the Great Recession, our pace (read: investment) has slumped, Simon says. That's not unique to the U.S.; investment has slowed worldwide. But "computing transforms itself on an exponential time-scale. If you sleep for three years, you're two generations behind," he says. "We slept for five years." Now China might be on track to beat us to exascale by the early 2020s.

Reaching exascale will be far harder than achieving historic gains though. We're hitting a power wall, says Steve Scott, chief technology officer at supercomputing firm Cray. "We can no longer run all our transistors full out; it would generate too much heat and

In 1957, the Soviet Union launched the first satellite, *Sputnik 1*, into orbit, spurring America to create NASA and DARPA, as well as train a generation of scientists and engineers.

In 1975, Intel co-founder Gordon E. Moore observed that the processing power (i.e., number of transistors) of an integrated circuit doubles every two years.

literally burn up the chips." In other words, improvements in power efficiency aren't keeping up with Moore's Law.

Instead, Scott says, we may need to rethink computing. If we can replace today's brawny chips with lots of simpler, more energy-efficient processors, they could handle enormous series of computations in parallel, like yoking an army of ants rather than a few hungry elephants. But that means figuring out how to break

down a computational problem into tiny parts for separate and nonsequential processing—a nightmare for software developers. (Which explains why such a leap has not yet been made.)

The U.S. government is engineering a comeback, if slowly. In July, the Obama administration established a National Strategic Computing Initiative to get back into international running. "It's an all-out approach," says Scott. No longer will agencies pursue isolated and arguably underfunded supercomputing goals—so long as Congress ponies up the extra cash.

The aim is to coordinate government agencies, academic institutions, and private companies. "We need to begin strategically ramping up our investment now," says Tom Kalil, deputy director for technology and innovation in the White House's Office of Science and Technology Policy. If we can combine the U.S.'s collective intellectual forces, as in the space race, we might be the first to reach the proverbial exa-moon. **ADAM HADHAZY**



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Every December, *Popular Science* honors the 100 greatest innovations of the year. Brilliant, revolutionary, and bound to shape the future—these are the Best of What's New.

ENTERTAINMENT

REPORTED BY ANDREA SMITH + MICHAEL NUNEZ



INNOVATION
OF THE YEAR

P/S

HTC Vive

WALK IN A VIRTUAL WORLD

Virtual reality is not that real if you can't walk around and interact with the world. The HTC Vive is the first virtual-reality system to offer that level of immersion. It uses two (or more) base stations to track your position as you move around a room. Hand controllers let you grab objects in the virtual world (and throw them across the room, if you want). The Vive is powered by the new digital gaming distribution service, SteamVR, which was built by gaming powerhouse Valve. That means you'll likely see VR versions of iconic games such as *Portal* and *Half Life* in the near future. For now, Vive is still a developer edition, but HTC promises that the headset will hit shelves before the end of the year.



Red Epic Dragon

A Camera Built for the Future

The Epic Dragon by Red captures more detail than any other camera in the world. It's the first to include a 6K image sensor—a higher resolution than most monitors can display—giving filmmakers more flexibility while editing. The quality is so good, scientists recently shuttled one to the International Space Station to film experiments. Head to NASA's YouTube page for unbelievable footage from the ISS.

From \$24,000



Samsung SUHD JS9500 Series Curved Smart TV

A 4K Television for the Masses

The Samsung SUHD series matches the quality of sharpest TVs on the market—but at half the price. The trick is in the nano-crystals, which are layered on cheap-to-produce blue LEDs and allow more backlight to shine through to viewers. That means sharper contrasts, more-accurate color, and brighter images fill the screen. The SUHD series also uses an eight-core processor to power the TV's smart operating system, letting users access Netflix, YouTube, and Playstation Now without the need for a set-top box. **From \$4,500**



IMAX Laser

The Best Way to Watch a Movie

IMAX has always offered a fully immersive cinema experience, but its projection system lacked a certain clarity. IMAX Laser fixes that problem. It provides the highest contrasts (and color range) of any projector ever. It also doubles the number of surround sound speakers in the theater to 12.

Sling TV

TV FOR CORD CUTTERS

Sling TV is a subscription service that lets users watch live and on-demand TV shows on Amazon Fire TV, Roku, Xbox One, Mac, Windows, iOS, Android, and some smart TVs. Popular channels like ESPN, CNN, and Cartoon Network can be streamed from anywhere in the U.S.—meaning the whole family will have something to watch. There are no DVR capabilities with Sling, but the upside is there are also no contracts. **Starts at \$20 per month**



Sphero BB-8

A STAR WARS DROID YOU CAN OWN

When *The Force Awakens*' trailer debuted this summer, the movie's star robot, BB-8, rolled onto the screen and into our hearts. Now, it's rolling into our living rooms. This 4-inch toy version has three modes: driving, which lets users direct the BB-8 using a joystick on your smartphone screen; holographic messaging, which uses the phone's camera and an augmented-reality engine to turn videos into *Star Wars* holographic messages (like in *A New Hope*); and patrol, which automates BB-8, documenting any collisions in its app. **\$150**



ZTE Spro 2 Smart Projector

A Wireless Projector and Hotspot

Wiring a projector can quickly turn into a tangled mess with video cables, power cords, and ethernet cables. The ZTE Spro 2 kills cables altogether. It's a portable 4G LTE hotspot, Android device, and wireless projector in one. The size of a book, the Spro 2 has a 5-inch touchscreen that runs the full Android OS, meaning you can project any app (such as Netflix and Instagram). The device can also provide Internet for up to 10 devices. **From \$400**



Meccano Meccanoid G15 KS

A DIY ROBOT YOU CAN TALK TO

The Meccanoid G15 KS is a build-it-yourself robot made from 1,223 parts that can rove around, crack jokes, and respond to questions. It's controlled by a tiny computer and stands nearly 4 feet tall when constructed. Users operate Meccanoid using a voice-command system. They can teach it new moves by moving its limbs like a puppet or using a drag-and-drop avatar in its companion app. Makers can rebuild Meccanoid into any number of forms, including a scorpion, raptor, and more. **\$400**

Nvidia Shield

BLAZING-FAST MEDIA CONSOLE

There's nothing worse than having your movie marathon rudely interrupted by image stuttering or buffering. That won't happen with the Nvidia Shield. The first 4K streaming set-top box employs the world's fastest mobile chip, Tegra X1, and gigabit ethernet to ensure it never hits a speed bump. It also doubles as a gaming console and runs on Android TV—so thousands of movies and games are already available. **From \$200**



GoPro Hero 4 Black

The Smallest 4K Action Camera

The most popular action camera now shoots 4K video—and it's still just the size of a Zippo lighter. The Hero 4 Black records ultra-high-definition video at 30 frames per second and HD video at 120 frames per second—fast enough for detailed slow-motion. The camera pairs with an app that lets users frame shots or review footage on the go. The GoPro Hero4 Black has also been used to film parts of the feature film *The Martian*, and if it's good enough for that, it's probably good enough for you. **\$500**



EA Star Wars Battlefront

Biggest Videogame Space Battle

For decades, *Star Wars* fans could only imagine what it might be like to battle in the snowy tundra of Hoth or the deserts of Tatooine. In *Star Wars Battlefront*, they can finally play out their favorite scenes (or rewrite history in this fictional universe). The game allows up to 40 players at a time, meaning there's plenty of warzone action. Weapons include lightsabers, X-wings, AT-ATs, and speeder bikes. Oh, yeah. And you can play as Luke Skywalker and Darth Vader. May the Force be with you. **\$60**



Philips Fidelio B5

Surround Sound in a Sound Bar

The Fidelio B5 looks like a regular sound bar, but the ends detach, so you can move them around the room, creating surround sound without the wires. Philips embedded a calibration system in each, so volume and balance self-adjust to provide the best sound possible. The two wireless speakers can also be moved to different rooms, morphing into portable Bluetooth speakers. That means you'll spend your next movie night engulfed in sound rather than huddled around the television. **\$900**

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Q+A

EDITED AND CONDENSED BY ERIK SOFGE

HOW TO CREATE A ROBOT ICON

Star Wars: The Force Awakens

doesn't hit theaters until December 18, but it already has a breakout star: BB-8, the endearing ball droid that made its debut in the movie trailer this summer. Rather than rely on computer graphics, director J.J. Abrams asked the film's creature-effects (CFX) team to create an actual BB-8 in the form of cleverly engineered props. We spoke with Matt Denton, electronic design and development supervisor, and Josh Lee, senior animatronic designer, about the inspiration and inner workings of the most iconic science-fiction robot in years.

Popular Science: How was BB-8 conceived?

Josh Lee: It was J.J.'s idea. We first saw it as a sketch on a napkin that had been scanned and emailed over to us. It caused a lot of head-scratching about how we would achieve it on set. So the first thing I did was build a model out of polystyrene and anything I could lay my hands on. I just wanted to get the movements down—the ball rolling, the head pitching. Instantly it was full of character.

PS: What did you do to give the robot personality?

Lee: You can cock the head. You can roll with the head pitched forward, which gives it a look of intent. As you go around a corner, you can lean the head into the corner to look controlled—but if you lean away, it looks wacky.

Matt Denton: In animatronics, our goal is to make robots not look like robots most of the time. If one looks robotic, usually we've failed. We try to make it look emotive and expressive, like an animal.

PS: How does BB-8 compare with *Star Wars'* first droid, R2-D2?

Lee: With R2 all you can do is rotate the head and make a sound—sad sounds, if he's sad. To make BB-8 look sad, you can just drop the head. All you have is a head—there are no eyes—but you can do a lot with that.

PS: What was the process of bringing BB-8 to life on the set?

Lee: When we were researching how to technically achieve this design, we thought of several ways of doing it. The first was to actually do it for real—get the head balanced on top

Engineers built seven versions of BB-8 for filming, plus one for red-carpet events.

COURTESY LUCAS FILMS



"IN ANIMATRONICS, OUR GOAL IS TO MAKE A ROBOT LOOK EMOTIVE AND EXPRESSIVE, LIKE AN ANIMAL."

of the ball and have that roaming around. It was very tempting, but it wouldn't have provided the precision of movement you need for filmmaking, or the reliability. So we came up with seven versions for the film—three main ones and some variations.

PS: How were they different?

Lee: One was the wiggler. It didn't roll around, but it could wiggle its head and body on the spot. We would bolt that to the set or bury a baseboard in the sand. Then we built the trikes because we needed a stable driving version. We motorized the ball and had the head move around on top by means of a curved track system. Motorized castors on the back allowed us to steer it. That version could go over pretty much any terrain. The only thing that defeated it was deep, very fine sand.

And then there was the puppet, which had an axle going through the ball, rods coming out, and a track system for the head. A puppeteer in a blue or green suit would hold the rods, and have very fine control over the head and ball. That's how we achieved some of the more-subtle acting shots.

PS: And yet another BB-8 rolled on stage at the *Star Wars* Celebration fan event in Anaheim?

Lee: Yes, in production we used those props. But I couldn't stop thinking about how we could make BB-8 for real. At *Star Wars* events you always see R2-D2, so I thought we would

need a BB-8 to go down the red carpet. In my spare time—weekends and evenings—I started working on it. And then Matt and I built a proof-of-concept model and showed it to Neal Scanlan [the head of the creature shop]. He showed the producers, and they released a bit of money to make it look like an actual BB-8.

PS: Does it work in the same way as the Sphero toy?

Denton: It's a totally different beast. Sphero is a hamster in a ball, and BB-8 has a head that's independent of the body so it can spin on the spot.

Lee: The Sphero toys are really fun because they're madcap and out of control. They roll all over. But when you're doing an event, you can't have that. You need to precisely puppeteer it. And that was a big challenge—figuring out how to get rid of all the wobble in a sphere mechanism.

PS: How does BB-8 compare with other animatronic projects that you've done?

Lee: It's entirely unique. It's the nicest thing I've ever made, and it also had the most interesting challenges.

Denton: The crew and the cast got really fond of it. People would sort of chirp at it as we carried it past. On its last day on set, it wrapped like an actor would and got a round of applause. That's certainly never happened to one of our robots before.

PS: Do you think it will invoke the same love in fans?

Lee: I don't want to jinx it, but yes [laughs]. It's been very strange because we spent the last year and a half keeping this massive secret, and now my son's got a BB-8, and it's on duvet covers—it's everywhere.

AUTO

REPORTED BY **ERIC ADAMS + KEVIN GRAY**

BMW 2016 7 Series

A NEW WAVE IN DRIVING

No longer will fumbling with a cellphone or reaching for a radio dial dangerously distract drivers. In October, BMW debuted the world's first-ever gesture control in a car, allowing drivers to answer calls, use navigation, and adjust audio, all with conductorlike hand waves. That makes everyone safer. It also hints at the potential for hands-free driving. If that weren't innovation enough, in U.S. models, BMW also

took up to 190 pounds off the car's weight, and improved fuel efficiency, by using carbon fiber in the chassis. That helps make the frame stiffer, which enhances performance. Luxury details also make the car feel like it belongs in a pricier class: Massage seats for rear passengers are helpful on long rides, LEDs in the moon roof mimic a starry sky, and programmable scents, like "woody," emanate from the dash. **\$81,300**



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Oshkosh Light Combat Tactical All-Terrain Vehicle

A Blast-Proof Truck

In August, Oshkosh won a \$6.7 billion defense contract to deliver the first new combat truck in 30 years. The Light Combat Tactical All-Terrain Vehicle has the ballistic protection of a light tank and the off-road agility of a Baja racer. It will replace the beloved (and hated) Humvee in coming years. The truck, which can carry more than the Humvee, uses bomb-resistant shaping and shielding similar to bigger and heavier tanks.

Cadillac
CT6 Rear
Camera
Mirror

A REAR VIEW THAT SEES IT ALL

Among auto designers, rearview mirrors are rarely proving grounds for innovation. The new mirror in the CT6 stands apart. With the flick of a switch, drivers can convert it into an HD display. A camera captures a live stream from the car's rear, which improves field of vision by 300 percent. The camera can enhance low-light scenes, manage brightness, and minimize glare. It's a new way to see the road. **Option \$2,500**



Volvo XC90

Safest Car on the Road

For a company that has built its name on safety, the Volvo XC90 is a signal achievement. The car acts like a co-pilot. With radar, cameras, and lane-drifting sensors, it will alert a distracted driver to pay attention, warn if you're about to strike another vehicle, and take control to prevent a crash. And if the car leaves the road, the seat frames crumple downward and the seat belts tighten to reduce the risk of serious injury. **\$49,800**



Tesla Motors Model X

Fastest SUV Ever

The Model X challenges pretty much every assumption about SUVs. It's fast: It races from 0 to 60 in 3.2 seconds and tops out at 155 mph. It's safe: The bottom-mounted battery panel gives it the lowest center of gravity (meaning less chance of rollover) of any SUV made. And it's slick: Falcon wing doors and a curved windshield make sure you'll be the envy of any driver—especially other soccer dads. **Price Not Set**

Acura 2017 NSX

A 190 MPH HYBRID

Hybrids are the new supercars—and Acura has just proved it. It has created a three-motor system for the NSX that maximizes handling, responsiveness, and fuel economy. It combines a midmounted twin-turbo V-6 engine with an electric motor—which delivers zero-delay acceleration—and with a motor at each front wheel. That provides precision power through a technique known as torque vectoring. So you have a car that jumps off the line and tackles turns like an IndyCar. **\$155,000**





Kawasaki Ninja H2

FIRST SUPERCHARGED STREET MOTORCYCLE

With the Ninja H2, Kawasaki has created the first supercharged consumer motorcycle—one of the fastest bikes on the road. Superchargers usually appear only on niche racing bikes. They work by pressurizing the air/fuel mixture before it enters the engine, creating a powerful combustion. But they tend to be big and heavy. Kawasaki made a light, compact unit with 3-D-printed parts. The bike can reach 186 mph—not that you'd see it coming. **\$25,000**

Divergent Micro-factories Blade

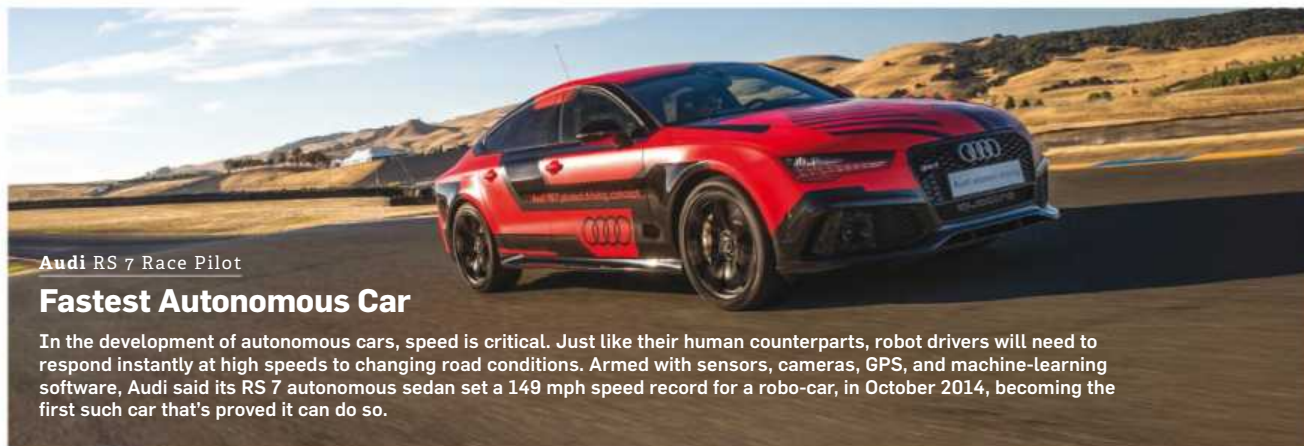
A 3-D-PRINTED SUPERCAR

Last May Kevin Czinger created the Blade—the first high-performance supercar that uses 3-D-printed parts and a process that cuts typical auto factory carbon emissions by up to 90 percent. By using carbon-fiber shafts and 3-D joints for the chassis, a car can be assembled in minutes. As founder of Divergent Microfactories, Czinger plans to open similar places for entrepreneurs to create their own car lines—for as little as \$4 million.

Google Android Auto

Best Smartphone Interface

Automakers continued to roll out systems to streamline the link between car and smartphone this year. Android Auto wins. It uses voice commands to make calls, select music, and get directions. And its Google Maps offers lane guidance for tricky interchanges, the latest traffic data, and directions to the nearest coffee shop.



Audi RS 7 Race Pilot

Fastest Autonomous Car

In the development of autonomous cars, speed is critical. Just like their human counterparts, robot drivers will need to respond instantly at high speeds to changing road conditions. Armed with sensors, cameras, GPS, and machine-learning software, Audi said its RS 7 autonomous sedan set a 149 mph speed record for a robo-car, in October 2014, becoming the first such car that's proved it can do so.

GADGETS

REPORTED BY ANDREA SMITH + MICHAEL NUÑEZ

Amazon Echo

HAL FOR YOUR HOME

For a long time, artificial intelligence existed only in science fiction. Then it started to creep into industrial computers and even phones. Now, it's coming to your home—and it's coming in the form of a speaker. The Amazon Echo acts as an intelligent hub for the house, linking together other smart appliances with a voice interface. Once set up, it listens passively at all times. When someone says the wake word—Alexa—it snaps into action. For now, those actions are limited to simple operations, like reciting your calendar events, queuing up your favorite playlist, relaying weather or sports scores and, of course, ordering household items from Amazon. But those tasks won't remain simple for long. In June, Amazon released the Alexa Skills Kit (ASK), opening the platform to dozens of third-party services, devices, and apps, including WeMo, Philips Hue, Pandora, and Wink. Hal 9000, eat your heart out. \$180

Microsoft HoloLens**A Headset That Creates Holograms**

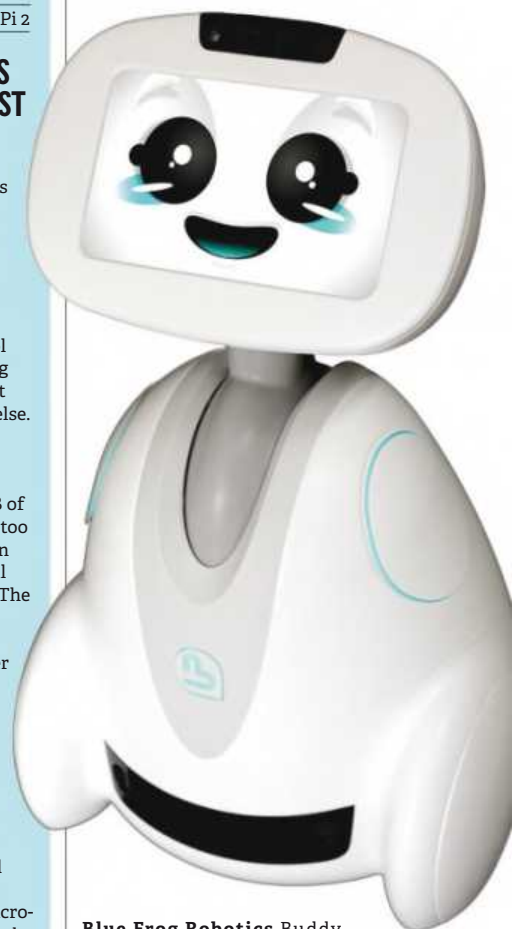
Google Glass may have pioneered augmented reality, but Microsoft HoloLens could well perfect it. The headset overlays digital images onto the user's real-world view. You can turn your living room into a gaming studio or draw on physical objects. NASA astronauts on board the ISS are working with Microsoft to use HoloLens for research and repairs. The first developer kit ships in early 2016. **\$3,000**

HearNotes WireFree Earbuds**Earbuds for Cord Cutters**

There's nothing more annoying than having to untangle headphone cables, so HearNotes cut the cords. Its WireFree Earbuds work with a transmitter that plugs into a standard headphone jack and have a range of 50 feet. And you don't have to worry about distortion. HearNotes uses Klear Technology, which was built specifically to deliver lossless, uncompressed hi-fi stereo audio. **\$350**

Raspberry Pi Foundation
Raspberry Pi 2**WORLD'S CHEAPEST PC**

Three years ago, when the first Raspberry Pi hit shelves, it was the perfect tool for learning to code, but not much else. Its meager 700 MHz processor and 512 MB of RAM were too weak to run meaningful programs. The Raspberry Pi 2 is six times faster than its predecessor and packs double the memory into the same credit-card size. In August, Microsoft released a Pi-friendly version of Windows 10, enabling more people to program, hack, and tinker. Best of all, the price is still right. **\$35**

Blue Frog Robotics Buddy**A ROBOT AT YOUR BECK AND CALL**

If you've ever dreamed of having a robot minion a la Luke Skywalker or George Jetson, good news: Now there's Buddy. The 2-foot-tall robot can serve as a rolling home-security system, remote control for your gadgets, and personal assistant. It sees, hears, and speaks through an 8-inch tablet that serves as its face and brain. Buddy's software was built on Unity, a popular gaming engine, so it's easy for developers to build custom apps and features. **\$750**

GADGETS

Best of What's New

DJI Inspire 1

THE ULTIMATE DRONE FOR FILMMAKERS

Drone footage can be spectacular, but it's notoriously difficult to film well. The DJI Inspire 1 makes it a whole lot easier. The 4K video camera—a first for a consumer drone—sits in a proprietary gimbal system and can be modified with custom lenses. Also, the craft's landing gears rise in flight for unobstructed 360-degree views. But perhaps its best feature is that two users can operate it simultaneously: One can fly while the other controls the camera, making it easier to get the perfect shot. **\$3,400**

USB Type-C

THE NEXT USB PORT

After a decade of stagnation, the lowly USB port received an epic overhaul this year. USB Type-C supports double the data-transfer speeds, cuts charging time by four, and is (finally!) reversible, so you don't have to figure out which side is up. Apple and Google are already using it in their newest flagship laptops, and many other smartphone- and laptop-makers are expected to adopt it. Prepare to see this port everywhere.



Seek CompactXR

A Thermal Camera for Your Phone

The Seek XR Thermal Imaging Camera turns a traditionally expensive and clunky device into an affordable, pocket-size iPhone or Android accessory. The small infrared camera is not as detailed as the thermal cameras used by handymen, but it more than gets the job done, whether that is detecting insulation leaks, frozen pipes, or taking some really far-out selfies. **\$300**



Pebble Time Steel

Longest-Lasting Smartwatch

For all the bluster around smartwatches this year, most come with an Achilles heel: They need to be charged once or even twice a day. The Pebble Time lasts for 10 days on a single charge. The secret is the watch's highly efficient color e-paper display, the first one in a consumer gadget. Bonus: It's easier to read the display under varied light conditions. **\$250**



Apple iPhone 6S

3-D at Your Fingertips

The first iPhone in 2007 introduced consumers to pinch to zoom, swipe to scroll, and pull to refresh—gestures that have become nearly universal. The iPhone 6S adds another with 3-D Touch. The feature uses a sensor to detect the amount of pressure applied by a user's finger. Message previews, status updates, and other shortcuts pop out of apps when the screen is pressed firmly. For now, only a handful of the most popular apps use 3-D Touch, but it's only a matter of time before it too becomes part of our everyday lexicon. **From \$650**



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INTRODUCING
amazon echo



THE MATRIX

THE REAL DEAL ON ARTIFICIAL INTELLIGENCE

As our favorite companion robot Buddy can attest, artificial intelligence reached a fever pitch in 2015: Humanoids now greet customers in retail stores, intelligent speakers control your smart home, and digital assistants have taken over your scheduling. Some are helpful. Some are creepy. All are here to stay. **LINDSEY KRATOCHWILL**



CLOCKWISE FROM TOP LEFT: COURTESY AMAZON; COURTESY FACEBOOK; COURTESY APPLE; COURTESY GOOGLE; COURTESY JIBO; KIYOSHI OTA/BLOOMBERG VIA GETTY IMAGES; COURTESY MICROSOFT; DAVID WARE/IL/ANADOLU AGENCY/GETTY IMAGES; COURTESY DOMINO'S; COURTESY RELAY; COURTESY X.AI

The new iPhone is here.

And only AT&T gives you the network
with the nation's strongest 4G LTE signal.



iPhone 6 

With 3D Touch, Live Photos, 7000 series aluminum, A9 chip, advanced cameras, a Retina HD display, and so much more, you'll see how the only thing that's changed is everything.

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SECURITY

REPORTED BY **KELSEY ATHERTON + KATIE PEEK**



August Home
August Smart Lock

**NEVER
LOSE
YOUR KEYS
AGAIN**

The August Smart Lock unshackles your home from the tyranny of physical keys. The 3-inch cylinder fastens to the back of an existing deadbolt, leaving the outside appearance of your door unchanged. Once attached, a Bluetooth signal from your smartphone can flip the mechanism to unlock the door. A guest with a smartphone and an August app can enter once you've granted them access. No more passing out hard-copy keys, which are much harder to revoke—and easier to lose. The Smart Lock lets you pick days and times for guest entry, so the dog walker can get in only during lunch hours, or your weekend Airbnb guests lose access once their stay is over. If your guests don't have smartphones, a Wi-Fi add-on allows you to buzz them in remotely. Plus, you can set the Smart Lock to bolt automatically every time the door shuts. And should anything fail, the old key still works. **\$229, plus \$50 for remote connectivity**



Inrad Optics
Stilbene Crystals

A CRYSTAL THAT DETECTS NUCLEAR RADIATION (NO, REALLY)

Stilbene crystal is stable, safe, and glows purple—scintillates, technically—when it is in the presence of radioactive materials such as plutonium. Stilbene's scintillating abilities were discovered in the 1940s, but optics manufacturer Inrad's commercial version has just started appearing in prototype homeland-security detection devices.

CRYPTO
MOBILE

Turing Robotic Industries
Turing Phone

Hack-Proof, Shatter-Proof Phone

With just a single port and waterproofing inside and out, the Turing Phone is designed to be indestructible. For the shell, the company uses an alloy dubbed "liquidmorphium."

Because the molecules in liquidmorphium are arranged amorously, rather than in the rigid structure of metals, the alloy is less prone to bending or breaking. The software is designed to be indestructible too. While no system is truly hack-proof, Turing has made breaching their flavor of Android so computationally expensive that they think hackers won't bother trying. And when users dial other Turing Phones, the calls are fully encrypted end to end—no third-party authentication necessary. **\$740**



Aquila and Sandia National Laboratories
BaDx

Smallest, Safest Anthrax Detector

Anthrax, a bacterial disease of grazing animals, can be a deadly terrorist tool. Now Sandia National Laboratories and security-technology company Aquila are making it simple to detect. They're producing a credit-card-size lab-on-a-chip that's akin to a pregnancy test: Inject a sample and wait a few hours for a line to appear. Because the test is portable, samples won't accumulate in labs—which is a security risk. It will help ranchers around the world detect the disease in their livestock. Aquila, which is producing the tests in partnership with Sandia, began shipping units earlier this year and plans to adapt the technology for other bacteria like *E. coli*.



Malloy Aeronautics
Hoverbike

A FREAKIN' HOVERBIKE

Mobility is a perpetual problem for soldiers on the ground, especially in the challenging terrain of today's conflicts. Enter the hoverbike, a mash-up of a motorcycle and a quadcopter. Malloy Aeronautics has a working prototype, and this summer, the U.S. Army Research Laboratory contracted the company to test if the hoverbike could work for soldiers. Civilians might want them too: Malloy suggests it could find use among land inspectors and search-and-rescue teams.

DroneShield

EARS, NOT EYES, IN THE SKY

At the Boston Marathon this year, the DroneShield team worked with city police to deploy 10 detectors that listen, rather than look, for potentially dangerous airborne threats delivered by drone. The unit cross-references audio it picks up with a library of drone sonic signatures, and sends an alert if it finds a match. DroneShield has installed its ears in the sky around office buildings, prisons, airports, and private homes.

Peerio

EASY, SECURE MESSAGING

In our post-Snowden world, secure messaging is ever more appealing. The standard encryption method is PGP, or "Pretty Good Privacy." It uses several layers of encryption to ensure messages can be read only by the intended recipient. But PGP can be tricky to set up. Enter Peerio, which provides easy-to-use PGP-level encryption for messages and file storage. Just download the software, have your would-be communicants do the same, set up a secure pass phrase, and chat away. Secretly. **Free**

Anti-Theft Dots

Get Your Stuff Back

Cops across the country have rooms packed with stolen items but no way of locating their owners. Anti-Theft Dots fix that. They're tiny nickel disks with identifying numbers chemically etched into them that link owners and property through a database. Their adhesive glows under black light, alerting cops to their presence, and can be applied to nearly anything: laptops, watches, TVs, and bikes. By year's end, 2,000 police forces nationwide will support them.

\$33 per kit, which can mark 50 items

New York City Police Department DAS Mobile

The App That Keeps Cops Safe

Relaying 911 information to cops on the beat—by radio—hasn't changed in decades. But there's only so much intel dispatchers can convey that way. This year, the New York City Police Department—the largest force in the United States—began sending ancillary data to some cops via smartphone. It's the first police force in the country to do so. The app is secure, requiring a PIN code and an ID scan to log in. Cops get background intel on prior arrests and outstanding warrants at the dispatched address, or helpful details such as whether burglars typically enter it by the back door. For an officer on the street, such extra information can be lifesaving.



BEST
OF
WHAT'S
NEW



AEROSPACE

REPORTED BY ERIC ADAMS + SOPHIE BUSHWICK

European Space Agency
Rosetta

COMETS FINALLY GET THEIR CLOSE-UP

For the first time in history, humans put a spacecraft in orbit around a comet and, in another first, landed on it. The European Space Agency's *Rosetta* spacecraft traveled 10 years and nearly 4 billion miles to Comet 67P/Churyumov-Gerasimenko. Once it arrived in November 2014, the Philae lander descended to the comet's surface, bounced, and came to rest in a dark area near the

edge of a crater. Unable to recharge through its solar panels, Philae went into hibernation—but not before transmitting data about 67P's makeup, internal structure, and wealth of organic molecules. As the comet hurtled toward the sun, the *Rosetta* orbiter stuck with it, observing as its frozen gases warmed and escaped into space. This data should provide valuable clues to the history of our solar system.



X-Avionics Xavion

The App That Will Make Emergency Landings

“It’s not just engine failure. Say you have an electrical failure, or a medical emergency, and need to set it down right away. This gives me advice and helps me make a good decision quickly—and that’s a big deal.”

—KEN PEPPARD, AVIATION SAFETY EXPERT



Boeing 777X

Ultra-Efficient Folding Wings

Wing size matters—bigger wings generate greater lift, which can improve an airplane’s fuel efficiency. With a 235-foot wingspan, one of the largest in the industry, Boeing’s new 777X twin-engine airliner will undercut its competitors in both fuel consumption and operating costs per seat. Thanks to their carbon-fiber composition, the wings are both strong and flexible—and the tips even fold up so today’s airports can accommodate their wider span.



Sikorsky Aircraft S-97 Raider

Fastest Helicopter

Designed by Sikorsky as an attack and transport vehicle for the U.S. military, the S-97 Raider has a top speed of 276 miles per hour, nearly twice that of a conventional helicopter. It’s also quieter, can climb higher, has a smaller turning radius, and—thanks to a rigid coaxial rotor and pusher propeller—is more precise and maneuverable. The full-size vehicle, which can carry two crew members and six soldiers, took its maiden flight this May.

DHL Parcelcopter

REAL-WORLD DRONE DELIVERY

In late 2014, shipping company DHL began making several deliveries a day to the remote North Sea island of Juist, Germany, dropping off medical supplies and other necessary goods. And for the first time in a real-world program, autonomous flying drones performed the work. The Parcelcopters persisted even in high winds, snow, and dense fog. The pilot program proved that, in case of emergency, deliveries needn’t rely on scheduled, human-operated services.



AT YOUR SERVICE

**NASA, Johns Hopkins
University Applied Physics
Laboratory, and Southwest
Research Institute**
New Horizons

VOYAGE TO PLUTO

When *New Horizons* launched almost 10 years ago, our sharpest image of Pluto was a fuzzy ball. This summer, the mission's flyby captured stunningly clear photos of the dwarf planet—and the never-before-seen heart-shaped area on its surface. In addition to cameras, *New Horizons* carries the most comprehensive suite of instruments ever sent to an unexplored world. The probe will study Pluto's atmosphere and composition, and teach us more about how our solar system formed.



**Naval Research
Laboratory**
*Close-In Covert
Autonomous
Disposable Aircraft
(CICADA)*

SWARMING MICRO- DRONES

Picture a paper airplane made of circuit boards, and you've just conjured a Close-In Covert Autonomous Disposable Aircraft (CICADA)—an inexpensive, 2.5-ounce glider developed by the U.S. Naval Research Laboratory. Dropped from midair and guided by a GPS system, the micro-UAV can adjust flaps on its wings to crash-land within feet of a target located miles away. In swarms of dozens, or even hundreds, CICADAs could serve as cameras, microphones, sensors, and weapons detectors, or form a communications network.



XTI Aircraft Company *TriFan 600*

Vertical Takeoff in a Civilian Airplane

For the executive who has everything, now there's the TriFan 600, an airplane and helicopter in one. The six-seat concept will use three ducted fans to rise vertically like a helicopter. Once it's airborne, two fans will pivot to generate forward momentum and provide lift so it can fly like a conventional jet. This August, after three years of development, XTI announced a crowdfunding campaign, which will cover a portion of the program's costs and give potential buyers a chance to back it.



Blue Origin *New Shepard*

A Manned Rocket for Tourists

Blue Origin's launch of *New Shepard* in April marked the first successful test of a vertically launched vehicle to lift tourists and researchers into suborbital space. The crew capsule separated from its booster, as planned, and parachuted safely back to Earth. The booster is designed to be reusable too, though a hydraulics failure prevented it from sticking the landing. Blue Origin has made *New Shepard*'s BE-3 engine available for licensing, which means other companies could also use it to get off the ground.



Solar Impulse *Solar Impulse 2*

Longest Solar- Powered Flight

Solar Impulse 2 has flown past a few world records in its quest to circumnavigate the globe. By spending nearly five days in the air this summer (117 hours and 52 minutes, to be exact), the plane made the longest nonstop flight by a solar-powered aircraft. Piloted by co-creator André Borschberg, it was also the longest solo flight ever. During the day, 17,248 solar cells provided power, and the airplane stored energy in lithium-polymer batteries to stay aloft through the night.



EDITED AND CONDENSED BY SOPHIE BUSHWICK

EXPLORING EVERYONE'S FAVORITE (FORMER) PLANET

In July, the *New Horizons* spacecraft zipped past Pluto at more than 30,000 miles per hour. But other than snapping our first close-up views of the dwarf planet, what was the point of this decade-long trip? We asked Cathy Olkin, the mission's deputy project scientist, what we can learn from Pluto and its moons—and where *New Horizons* is going next.

Popular Science: Why is Pluto so important?

Cathy Olkin: Pluto is the best known of the Kuiper Belt objects, the bodies that inhabit the outer solar system. Think of the Kuiper Belt as the deep freeze of the solar system, or the attic where you put all of the pieces left over from its youth. By looking at these more-primordial bodies, we can better understand the solar system's architecture and formation.

PS: Did you ever think you'd make it?

CO: I've worked on this project for more than a decade. When we launched in 2006, the year 2015 sounded fictional. It was hard to imagine that it would ever

7,750

New Horizons'
closest
approach to
Pluto, in miles,
during its flyby

arrive. And then it did. As we got closer to the encounter, we began getting new views of Pluto every day. I just wanted to slow down time, to make it last.

PS: What have you found so far?

CO: Pluto has been quite surprising. The mountains are fascinating. They're about the height of the Rockies, and because of their shape and how steep the sides are, we believe they might be mountains of water ice. We also see what looks like the glacial flow of exotic ices. That could mean there's a source of these ices that's upwelling, or it could mean there's heat coming up from inside Pluto to keep the ices a little warm. We've also seen haze high up in the atmosphere—I think it's about 150 miles. For years I studied Pluto's atmosphere from the ground, and there had been a question: Is there haze? So it was just stunning to see.

PS: What else are you looking forward to discovering?

CO: It will probably take a little more than a year to get all the data. So I'm looking forward to seeing new terrain. We'll also get more information that will help us really understand what molecules are on the surface, making up these different features.

PS: What's next for the probe?

CO: The spacecraft has passed by Pluto and is continuing to fly on. We've identified a potential second target, a smaller Kuiper Belt object, that we want to propose for an extended mission. It gives us another sampling of what lies in the cold outer reaches of the solar system.

PS: So what do you think: Is Pluto a full-fledged planet?

CO: I naturally refer to Pluto as a planet because that seems like the right moniker. It has an atmosphere; it has interesting geology; it orbits the sun; it has moons. "Planet" just seems right to me.



There is something **TERRIBLY WRONG** with the Home Security Industry

Hi. Maybe you've been broken into before, or maybe you haven't. But if you ever decide to protect your home against unfortunate events like that, you're in for a shock. We don't want to scare you off of protecting your home, because honestly, it's really important that you do it. But we feel responsible for sharing these facts with you: Most alarm companies take advantage of people who want to feel safe. They offer you a "free" outdated alarm, but then require you to sign a long-term contract full of nasty fine print. It's pretty sickening really...but this isn't going to be all bad news. There is a better way to protect your home—get a SimpliSafe home security system. Our founder, a Harvard engineer, studied the alarm industry and found all kinds of problems with it. He designed SimpliSafe to fix them, so you can be safe, without having to spend a fortune or sign any contracts. SimpliSafe is wireless, you can order it online, and it's easy to install yourself—anyone can do it. It fits any home, apartment, or business. And it's more affordable, more reliable, and stronger than just about anything else out there.

Most companies say "trust us" and then ask you to sign on the dotted line. We're asking you to let us prove that a SimpliSafe home security system is the smarter choice. Try SimpliSafe for 60 days. We think you'll love it. But if you don't, that's okay too. Return it to us for a full refund, no questions asked.

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It's a special for Popular Science readers.



"Protecting your family is important, but don't ever sign a contract. Do it the right way with SimpliSafe."

—Dave Ramsey, financial expert & New York Times bestselling author



SOFTWARE

REPORTED BY ALAN HENRY + LINDSEY KRATOCHWILL

Twitter Periscope

A BROADCAST NETWORK OF YOUR OWN

The cameras in our pockets have granted amateurs all sorts of powers to reinvent themselves—first, as photographers and then as YouTube stars. Now with Periscope, anyone can become a broadcaster as well. The app makes live streaming events like the Black Lives Matter protests, raging wildfires, or even office antics as simple as pressing a button. The stream is accessible to anyone who also has the app installed on their mobile device. In the hands of journalists, Periscope has broadcast videos from the Syrian refugee crisis, putting a human face on a global crisis that for many is happening out of sight. Inevitably, it has also prompted privacy concerns and put more than one business model in jeopardy: Periscope was a popular way to illegally broadcast this year's expensive pay-per-view boxing match between Floyd Mayweather Jr. and Manny Pacquiao. **Free**





Microsoft
Windows 10

THE WINDOWS WE'VE BEEN WAITING FOR

“Easy” and “operating system” don’t tend to inhabit the same sentence, but Windows 10 could change that. The OS comes with face-scanning and fingerprint authentication for quick, secure logins. It also has Cortana, Microsoft’s virtual assistant (think Siri for the Windows set), which can schedule meetings, check weather, or do Web searches all with a simple voice command. The OS runs on desktops, laptops, touchscreen tablets, and phones—making it even easier to switch between devices or use tablet-laptop hybrids. **Free Upgrade**

Danish Blind Society RenderMan

A Smartphone App That Gives the Gift of Sight

Phone cameras aren’t all that useful to someone who’s blind—not, at least, until Be My Eyes. The app, developed by the Danish Blind Society, connects visually impaired users to sighted ones. Through a live video feed, sighted users can decrypt unfamiliar street signs, expiration dates on food packages, or anything else that needs a quick visual assist. Since it launched in January, the app has helped 23,000 users over 100,000 times. **Free**



Google
Photos

ADDING GOOGLE SMARTS TO YOUR PHOTO APP

No longer must you endlessly scroll through digital photo albums: Google integrated search into its Photos app. Query France, and you’ll soon have every photo you ever took on that trip to Provence. You can do the same for your son. For his lifetime. Google’s assistant will then organize those photos for you. It will even turn them into animated gifs or correct lighting or contrast flaws automatically. Plus, the perks of the old version are still there: simple back-up, mega storage, and easy editing. **Free**

IBM Watson

Team Up With Watson

The supercomputer that won *Jeopardy!* is now available to anyone. IBM expanded its developer ecosystem for Watson by adding advanced language, speech, and vision capabilities, making it easier for partners to tap into Watson’s cognitive-computing abilities to solve problems.

SoundHound Hound

Nimble-Minded Digital Assistant

Instead of waiting to process a request or query until after you ask it, the Hound app sniffs out the results in real time. Thanks to natural language processing, it can also understand complex queries (“Show me four- or five-star hotels in Miami for two nights, starting on Friday, between \$150 and \$200 a night”), and it can build upon those results to more finely hone the answers you’re seeking. **Free**



Pixar RenderMan

Create Your Own Toy Story for Family and Friends

Pixar’s in-house 3-D-rendering engine—used to create movies such as *Toy Story* and *Up*—was the first piece of software ever to earn an Oscar. More recently, the studio noticed there was a significant technology gap between public and professional software, so it released a consumer-friendly version of RenderMan. Intended for educational and personal use, the app is strictly prohibited for commercial purposes. **Free**

HEALTH

REPORTED BY SARAH SCOLES + BREANNA DRAXLER

**Merck Sharp & Dohme**

VSV-EBOV

PREVENTING THE NEXT PANDEMIC

A new vaccine usually takes six to 10 years to go through clinical trials. The Ebola vaccine took only 10 months. When the West African outbreak was declared a global health emergency in August 2014, the World Health Organization fast-tracked the process. The vaccine, made by swapping proteins from Ebola into another virus, triggers an immune response that protects people from contracting the actual disease. To test its efficacy, health workers in Guinea used a “ring strategy” around the 100 confirmed Ebola cases in the country. First, doctors vaccinated roughly 4,000 adults who had come into contact with the infected patients. None got Ebola. For a control group, they vaccinated another approximately 3,500 people three weeks after identifying the latest infection. Only 16 contracted the disease. “The ring strategy hinges on vaccinating all contacts of a recently confirmed case, and their contacts in turn, virtually creating a firewall and stopping transmission in its tracks,” says Marie-Paule Kieny, WHO’s assistant director general for health systems and innovation, who led the R&D. The Ebola vaccine showed that scientists can develop and deploy lifesaving drugs quickly—in the future, preventing other diseases from going global.



Skulpt Aim**A MONITOR WITH MUSCLE****For gym rats**

scales can show body weight, but not muscle condition or body fat—important measures of fitness. Aim does both. When placed on the skin, the device sends a weak electric current through the body. Since muscle and fat have different resistances,

it can tell them apart. Aim determines the strength of a muscle relative to its size too, so you can see the direct effects of a workout (or a lazy streak). A medical-grade version can monitor the impact of degenerative diseases like muscular dystrophy or amyotrophic lateral sclerosis (ALS). **\$149**

**iCad**
Xoft System**TARGETED CANCER RADIATION IN ONE GO**

Radiation therapy for breast cancer can require eight weeks of near-daily trips to the hospital. A method called intraoperative radiation therapy takes less than 12 minutes total. During a patient's tumor-removal surgery, a radiation oncologist delivers a single, concentrated dose of radiation. It aims to kill any malignant cells the surgery might have missed, and helps prevent cancer from returning during recovery. Two recent clinical trials have found it to be as effective as conventional radiation. Plus, a patient experiences fewer side effects and is able to get back to normal activities much sooner.

Salk Institute Human Body Epigenome Maps**Maps for Precision Medicine**

“The Epigenome roadmap is as important as the Human Genome Project. We cannot interpret one without the other. The epigenome determines both the normal behavior of a cell or tissue and disease states such as cancer.”

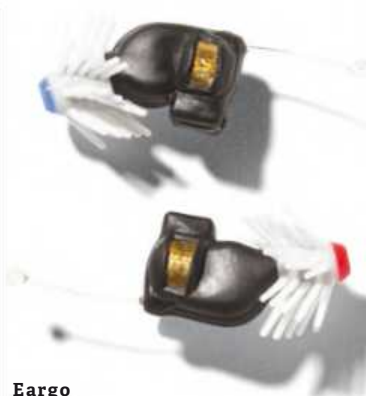
—ADRIANA HEGUY, DIRECTOR OF THE GENOME TECHNOLOGY CENTER AT NYU LANGONE MEDICAL CENTER

Medtronic Micra Transcatheter Pacing System**World's Smallest Pacemaker**

Doctors surgically implant most pacemakers in the chest and run wires from the device to the heart. The vitamin-size Micra can be threaded through the femoral vein into the heart with a catheter. Tines then attach to the heart to deliver electrical impulses directly. The battery lasts more than 10 years, and when it's depleted, doctors can disable the device and insert another nearby. So far, the success rate in trials is 100 percent.

**Force Impact Technologies FITGuard****A “Check Engine” Light for Your Brain**

A helmet is no longer an athlete's only line of defense against a concussion or other brain injury. Sensors inside the FITGuard measure linear and rotational acceleration of the head. The mouth guard then sends that data to a coach's phone or tablet on the sideline. When a player gets hit hard, LEDs light up to indicate he or she should sit out. On the bench, the associated app administers light-sensitivity and memory-loss tests to help determine the player's likelihood of a concussion. **\$100**

**Eargo****The Most Comfortable Hearing Aid**

Typical hard-plastic hearing aids block airflow and natural bass sounds. Eargo's featherlike silicone fibers suspend the device in the ear canal, making it almost imperceptible. “Comfort is important because you wear it all day long, every single day,” says Raphael Michel, the company's co-founder and CEO. A processor inside the device sends sound directly to the eardrum so you can better pinpoint the source. Bonus: The rechargeable battery never needs to be replaced. **\$1,980**

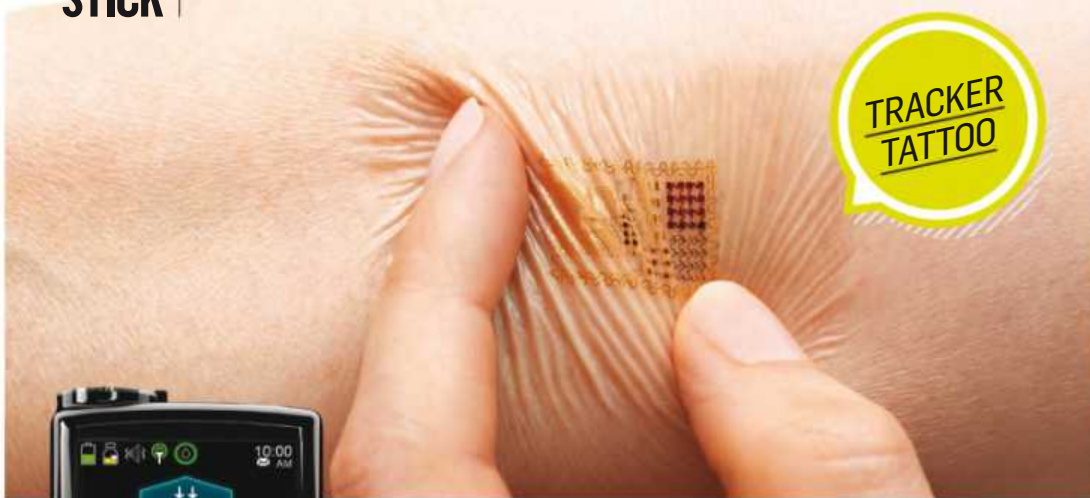
HEALTH

Best of What's New

MC10
BioStamp

HEALTH STATS THAT STICK

Wearables can be clunky. The BioStamp offers a stretchy alternative: an electronic device that sticks to your skin for up to a week, like a temporary tattoo. Thin sensors and circuits embedded in the adhesive-backed stamp measure biometrics like body temperature, movement, muscle activation, heart rate, and exposure to ultraviolet light. The device then relays this data to a wearer's (or a doctor's) cellphone via Bluetooth. Biostamps to check blood pressure and analyze sweat are in the works.



Medtronic
Hybrid Closed-Loop System

A Savior for Diabetics

More than a million people in the U.S. have Type 1 diabetes. They must constantly monitor their blood sugar and inject insulin to compensate for a subpar pancreas. Medtronic developed a system that uses an algorithm to automatically deliver an optimized dose, day or night. No mental math; no human error. "It's essentially the same system that drives a thermostat or cruise control," says Francine Kaufman, chief medical officer of the company's diabetes group. "Except that biology is more difficult to control."



Organovo exVive3D Kidney

3-D-Printed Tissue

Even after drugs have passed animal tests, many fail in human trials due to kidney or liver toxicity. Organovo, which last year 3-D-printed mini livers from human cells, can now synthesize individual mock kidneys. Each contains a number of different cell types in which drug effects can be tested. "Every single drug a pharmaceutical company develops has to be tested for safety in liver and kidney settings," says Keith Murphy, the company's co-founder and CEO. "Our system is meant to be the best and final test."



NovoBiotic Pharmaceuticals
Teixobactin

First New Antibiotic in Nearly 30 Years

Teixobactin can fight resistant strains of bacteria such as *Mycobacterium tuberculosis*, which (as its name suggests) causes tuberculosis. And because it binds to bacteria on two target regions, in contrast to most antibiotics' one, bacteria are less likely to develop resistance to it. The drug candidate is still in the pipeline and works for only certain bacteria, but one of them is invasive MRSA, which some 75,000 Americans contract every year.



Kolibree
Connected
Toothbrush

A 3-D-MOTION TOOTHBRUSH

Even with the built-in timer on some electric toothbrushes, most people don't brush for the full two minutes that dentists recommend. Kolibree is more foolproof; its 3-D motion sensors show, in real-time, how well you're scrubbing. It connects to your phone via Bluetooth to highlight problem areas and suggest improved brush motion or position. A connected game ensures kids will do more than just swallow the toothpaste. **\$149**

CLOCKWISE FROM TOP LEFT: COURTESY MC10; JONATHAN KAMBOURIS; COURTESY NOVOBIOLOGIC PHARMACEUTICALS; COURTESY ORGANOVO; JONATHAN KAMBOURIS

THE MATRIX

THE SKINNY ON HEALTH TRACKERS

One in five Americans now has a fitness tracker. The gadgets in this \$500 million market measure your every move (plus breath and heart rate). "We're beyond the glut of trackers that just monitor how many steps you take," says Christine Lemke, chief product officer for Evidation Health, a startup that evaluates the utility of health devices. But popularity breeds misconceptions. A PricewaterhouseCoopers survey found that nearly 60 percent of consumers believe wearables add 10 years to the average life expectancy. "There are a lot of trackers whose value is unproven," Lemke says. So here's how this year's releases stack up. **MATT GILES**

MOOV NOW

An accelerometer, gyroscope, and magnetometer (for directional movement) provide immediate feedback while you're slogging through that workout.

**SELFIE WORTHY****Sproutling**

Wrapped around a baby's ankle, Sproutling tracks skin temperature and body position. Plus, it learns napping patterns so you can schedule a few winks too.

**Hexoskin**

Sensors embedded in the fabric track breathing, pace, and heart rate. If you like your PJs snug, Hexoskin monitors sleep too.

**Jawbone UP3**

Bioimpedance sensors measure your steps, sleep stages, and heart rate. You can also set an "idle alert" to pull you out of a Netflix binge.

**June**

UV sensors monitor sun exposure and provide "sun dose" notifications to help prevent lobster burns. The downside to June: suntan lines on your wrist.

**Muse**

The *Star Trek* solution for staying focused: The Muse headset's seven EEG sensors provide a snapshot of your brain activity in real time.

**LOST IN A CROWD****ONE OF A KIND****Spire**

Clipped to a belt or bra, Spire monitors breathing. Prepare to see the real-time effects of that peppermint mocha Frappuccino.

**Microsoft Band**

Bill Gates wants to help you get a better night's sleep. Microsoft's wearable knows if you're awake, tossing and turning, or out cold.

**TempTraQ**

Rather than measure temperature under the tongue, TempTraQ adheres to your skin. It's ideal for feverish infants—or squeamish adults.

**Pavlok**

Can't quit smoking or biting your nails? Pavlok offers a high-tech wrist slap. It zaps you (mildly) when it detects you indulging in bad habits.

**SOCIALLY AWKWARD****UpRight**

Stuck to your lower back, the UpRight can tell when you slouch—and vibrates a warning every time you do.



HOME

REPORTED BY HARLAN MURPHY + LINDSEY KRATOCHWILL

TESLA

Tesla Motors
Powerwall

NOW YOU CAN SUPERCHARGE YOUR HOME

You've invested in solar panels to harvest energy from the sun, but without daisy-chaining an array of car batteries, you've got no way to store it. With the Powerwall, Tesla used its expertise manufacturing lithium-ion batteries for electric vehicles to provide a sleek alternative. The 210-pound wall-mounted battery can store surplus energy from solar panels. But it can also automatically bank electricity from the grid during off-peak times, when rates are lowest. That way you can power your home—or charge your Model S—for pennies even when electricity is in highest demand. The company makes a 7 kWh battery for daily use, and a 10 kWh version that can double as a backup generator. **From \$3,000**



WindStream Technologies SolarMill**An Alternative-Energy Powerhouse**

With limited roof space, it's often not possible for do-good homeowners to harness both solar and wind power. WindStream solved that problem by creating a hybrid system. A trio of corkscrew-shaped vertical-axis turbines turn below a photovoltaic panel, saving space. The system can generate 13 percent more energy than solar alone. **\$3,125**

**Stack**
Downlight**A BULB THAT GETS TO KNOW YOU**

What if your lights could understand their surroundings? Stack added occupancy- and ambient-light sensors to its LED Downlight bulbs. The result is a lightbulb with smarts: It can turn off when you leave a room and recognize when it's morning in order to wake you up. To protect you, the system can even mimic your lighting habits when you're away on vacation. Don't like the schedule? You can custom-program it yourself with a companion app. **\$99 (for a starter pack of two bulbs and a hub; \$35 for each additional bulb)**

Bosch Power-Ready Wireless-Charging System**TOOLS LEADING A WIRELESS REVOLUTION**

With its inductive-charging system, Bosch has made charging power tools effortless. Simply set the tool on its dock, and—*voilà!*—the electromagnetic field replenishes the battery. A full charge takes 50 minutes, but you may never need that: The batteries are lithium-ion, so you can top them off as you go.

**Dyson Humidifier****THE ULTIMATE CLEAN MACHINE**

Humidifiers can often be breeding grounds for bacteria. But that doesn't mean humans have to live with bone-dry air. Dyson's new humidifier zaps bacteria with ultraviolet light, killing 99.9 percent. It also uses the same "air-multiplier" technology as the company's fans, to ensure thorough room coverage. It's the first humidifier to earn an asthma and allergy-friendly certification from the Asthma and Allergy Foundation of America. **\$500**



Leatherman Tread

FIRST WEARABLE MULTITOOL

After Leatherman's president, Ben Rivera, got stopped at security at Disneyland for carrying a multitool, he decided to create one that you'd never need to leave at home—or even in a toolbox. Tread's wearable design features 29 handy tools, such as Allen wrenches, screwdrivers, and a bottle opener. **From \$165**

Briggs & Stratton
EXi Series
Engine

NEVER CHANGE YOUR OIL AGAIN

Manufacturers recommend you change your lawn mower's engine oil every 25 hours of use. To eliminate that messy hassle, Briggs & Stratton built its new EXi Series Engine. The engine is designed to run cooler because oil breaks down more slowly at low temperatures. (It also features an improved air-filtration system to run cleaner.) Rather than change the oil, just top off periodically to maintain proper levels. In a year, you'll end up using 73 percent less oil.



Channellock
86 9" Rescue Tool

REACT LIKE A FIRST RESPONDER

Police officers and firefighters aren't the only ones who have to grapple with emergencies. So why shouldn't homeowners use the same multitool they do when confronted with a storm or fire? The Rescue Tool combines five tools, including a spanner wrench to tighten and loosen hose couplings, a prying tip that can help jimmy open a stuck window, and cutting edges that can snip wire. **\$50**

Whirlpool HybridCare Heat-Pump Dryer

A Hybrid for Your Hamper

The average clothes dryer can consume as much energy per year as a refrigerator. To balance the scales, Whirlpool built a ventless heat-pump model. Instead of releasing hot, moist air, the HybridCare condenses the water internally. The dry air is then recirculated—reducing energy costs by 40 percent over standard dryers. **\$1,799**



DeWalt Carbon-Fiber Composite Level

A Level That Won't Give In to Pressure

Lightweight levels are typically made of aluminum. But over time—or with rough use—the material can deform and lose accuracy. That's why DeWalt built a level from a carbon-fiber composite. It's 35 percent lighter than aluminum counterparts and can absorb major impacts so it stays true to form. **\$100**



Affordable Hearing Aid Technology Only \$299!

Learn about our great digital technology at an affordable price.

The All New HCX!

- ✓ Digital sound processing chip provides crystal clear sound and makes speech easier to understand without feedback
- ✓ Multiple memory programs adapt to most listening situations
- ✓ Nearly invisible thin tube design
- ✓ Helpful low battery warning so you are never caught unprepared
- ✓ Long lasting size 13 batteries
- ✓ 10 bands of layered noise reduction helps to emphasize voices while balancing out background noise
- ✓ 100% Money Back Guarantee



The HCX™

★ Customer Reviews ★

"I will definitely recommend your company to my patients." - Dr. Arun P.

"I just want to let you know how happy my husband and myself are with his new hearing aids!... - Monique S.

Studies Show: Hearing Aids MAY HELP PREVENT DEMENTIA.

A study by Dr. Frank Lin at John Hopkins University, found that adults with hearing loss are significantly more likely to develop dementia and at a faster rate. Fortunately, the use of hearing aids is an effective way to treat hearing loss and may help you maintain healthy mental activity.

www.AdvancedHearing.com/Dementia



- A) Microphone
- B) Volume Control Wheel
- C) Program Button
- D) Long Lasting Battery
- E) Digital Signal Processor
- F) Receiver (Speaker)
- G) Sound Tube

SAVE \$50 ON A PAIR
And Get **FREE** 1 Year Supply Of Batteries*

Digital Hearing Aid Technology... For Only \$299!

All hearing aids work the same way. The **microphone** picks up the sound and sends an electrical signal to the digital signal processor. The **digital signal processor** is the "brains" of the hearing aid. It takes the sound it receives and adjusts the sound to amplify important speech sounds as well as filtering out unwanted noise. (To ensure the best in quality, our digital processor is designed and manufactured right here in the **United States**.) Once the processor has amplified the sound, it is passed to the **receiver** (also known as the speaker) which emits a corrected and amplified sound through the **sound tube** into your ear.

Most importantly, your new HCX hearing aids work at a **fraction of the cost** of name-brand hearing aids. In addition to the technical components of the hearing aid, you also have a **volume control** that can be modified with a light touch of the finger. Your new hearing aids come with **3 different audio programs** that help you listen in different sound environments. You will love the Open-fit design, that is so light you probably won't even feel that you are wearing your hearing aids – you'll just be hearing clearly!

You can spend thousands for a high-end hearing aid or you can spend **just \$299** for a hearing aid that just plain works (**only \$274 each when you buy a pair**). We are so sure you will love our product, that we offer a **100% Money Back Guarantee - Risk Free** if you are not satisfied for any reason. It's time to get great digital technology at an affordable price!

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Free 1 Year Supply Of Batteries!

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RECREATION

REPORTED BY **BERNE BROUDY + GRENNAN MILLIKEN**

Albedo100

Light-Reflective Spray

PAINT THAT CAN SAVE YOUR LIFE

When it comes to safety, staying visible at night is critical for runners, walkers, and cyclists. That's why Swedish startup Albedo100 has developed a reflective spray that can be applied to clothes and bike parts. The spray is invisible during the day but shines like a highway street sign at night when it comes under the glare of headlights. The spray is benign, so it doesn't damage materials or hurt your skin, and lasts about a week before wearing off. There's even another version of the spray that's safe enough to put directly on your pet's fur. Albedo100 released both versions of the spray earlier this year, and a third that works especially well on metals will be out by the end of the year. It also collaborated with Swedish carmaker Volvo to market the spray under the name Life Paint, which they hope to one day sell in the United States. Never stress over Halloween night again. **\$19**





Stower
Candle Charger

CHARGE YOUR PHONE WITH A FLAME

The Candle Charger by Stower uses an open flame to charge your mobile device. Here's how: You fill a small, specially constructed pot with water, place it on a stand, and set it over a burning fuel-canister candle. A USB cable attaches to the pot, providing a point of connection for your

device. As the water boils, the temperature difference between the water and flame creates an electric current that charges your phone. It's handy in the field but also in power outages. Plus you can then tell someone that you charged your phone with fire—because you did.

\$100

Voormi Fall Line Jacket with Core Construction

The Only Jacket You'll Need

Unpredictable weather in the backcountry means you have to carry many different layers to deal with the elements. The Voormi Fall Line jacket does away with that. This wool zip-up keeps you warm and comfortable in cool weather but also keeps you dry if you get caught in the rain. The Colorado company calls this Core Construction technology. It knits water-resistant material within the wool into a single layer. This makes it possible to have water-resistant clothes in virtually any material, including cotton and nylon. Voormi released the jacket this fall. **\$400**



Epson
M-Tracer
Golf Swing
Analyzer

GOLF COACH IN YOUR PHONE

Improving your golf swing is a lifelong pursuit—and an expensive one if you rely on a trainer or coach. The M-Tracer Golf Swing Analyzer and app put that expertise on your phone. A thumb-size "tracer" clips to your club and, as you swing, records 1,000 samples of movement per second and sends them to your phone. The resulting 360-degree 3-D image reveals club speed, attack angle, and more. It also records and saves each swing so you can compare strokes as you go along and track your improvement. **\$250**



Dainese D-Air Racing Misano Suit

FAIL-PROOF MOTORCYCLE AIRBAG SUIT

Motorcycle airbag suits and jackets have been around for years and typically require a tether, attached to the bike, to deploy. That's a problem if you're not thrown from the bike during a spill, and if they don't deploy quick enough. The D-Air is the first one in the U.S. that doesn't require a tether. The suit uses a suite of sensors that detects movement of the body or an imminent crash to trigger airbag deployment. This all happens in just 30 milliseconds. Although it's been available in Europe since 2012, it just reached the U.S. in September of this year. **\$2,500**

RECREATION

Best of What's New

Uvex
Snowstrike
VT Goggles

FIGHTER-PILOT GOGGLES FOR SKIERS

Skiing over uneven terrain with obscured vision isn't just annoying, it's dangerous. The Snowstrike VT Goggles make it a problem of the past by using the same technology found in fighter-pilot helmets. The goggles have sensors that gauge the intensity of outside light and send signals to LCD crystals inside the lenses to change the shade accordingly. In a tenth of a second, the tint morphs to purple, blue, red, or clear. So while flying down slopes at high speeds, and in and out of shade, the wearer will never have a momentary lapse of clarity. The tint can also be changed manually. **\$500**



Torquing Group Zano
Self-Tracking Drone

A Drone That Snaps Your Selfies

Flying a camera-equipped drone while taking footage requires dexterity. A little slip could send your drone plummeting to Earth. The Zano is a tiny quadcopter with an HD camera that flies and shoots by itself. It does this by following your smartphone via Wi-Fi. Using GPS and a barometric pressure sensor to navigate and estimate altitude, it films you as you go about your vacation or your daily run. Presets can make it stay in one place, or track your every move. The little hummingbirdlike drones started shipping to customers in November. **From \$310**



MSR Guardian Purifier

Drink Water from a Mud Puddle

The U.S. military asked backcountry outfitter Mountain Safety Research (MSR) to create a device that could protect troops from waterborne illness anywhere they deploy. The company came up with the Guardian Purifier, which uses medical-grade fibers to block out dangerous pathogens, such as bacteria, protozoa, and viruses, along with particulate matter like sediment and silt. Also, the device never requires a cleaning: It uses about 10 percent of the water it pumps up to flush out the blocked contaminants. Now it's available to you. It debuted in August 2015. **\$350**

Avatech Avanet Cloud Platform/Mobile App

An App That Helps You Avoid Avalanches

Unstable snowpack and bad weather increase the dangers for climbers, hikers, and skiers in the mountains. To avoid being caught off-guard, mountain-safety company Avatech has built a mobile app that collects crowdsourced weather and snowpack information for backcountry enthusiasts to access in both hemispheres—and hike accordingly.

From \$5 per month

Not getting the sleep you need? Is your pillow the problem?

On its 10 year anniversary and with over five million satisfied customers, MyPillow® has been selected the *Official Pillow of the National Sleep Foundation!*

How Well Did You Sleep Last Night?

Did you toss and turn all night? Did you wake up with a sore neck, head ache, or was your arm asleep? Do you feel like you need a nap even though you slept for eight hours? Just like you, I would wake up in the morning with all of those problems and I couldn't figure out why. Like many people who have trouble getting a good night's sleep, my lack of sleep was affecting the quality of my life. I wanted to do something about my sleep problems, but nothing that I tried worked.

The Pillow Was the Problem

I bought every pillow on the market that promised to give me a better night's sleep. No matter how many pillows I used, I couldn't find one that worked and finally I decided to invent one myself. I began asking everyone I knew what qualities they'd like to see in their "perfect pillow", and got many responses: "I'd like a pillow that never goes flat", "I'd like my pillow to stay cool" and "I'd like a pillow that adjusts to me regardless of my sleep position." After hearing everyone had the same problems that I did, I spent the next two years of my life inventing MyPillow.



Mike Lindell
Inventor of MyPillow®

MyPillow® to the Rescue

Flash forward ten years and MyPillow, Mike Lindell's revolutionary pillow design, has helped 5 million people improve the quality of their sleep. MyPillow has received thousands of testimonials about the relief MyPillow has brought to people who suffered from migraines, snoring, fibromyalgia, neck pain and many other common issues.

Lindell has been featured on numerous talk shows, including *Fox Business News* and *Imus in the Morning*. Lindell and MyPillow have also appeared in feature stories in *The New York Times* and the *Minneapolis Star Tribune*. MyPillow has received the coveted "Q Star Award" for Product Concept of the Year from QVC, and has been selected as the Official Pillow of the National Sleep Foundation.

MyPillow's patented technology can help with all of the most common causes of sleep loss and allows you to adjust it to any sleeping position. You can even wash and dry MyPillow as easily as your favorite pair of blue jeans!



"Until I was diagnosed with various sleep issues, I had no idea why my sleep was so interrupted throughout the night. I watch Imus each morning and heard endless testimonials about MyPillow. I took his advice and ordered a MyPillow. Now I wake up rested and ready to conquer the day ahead. Thank you for helping me remember what it's like to sleep like a baby!"

- Jacqueline H.



Unprecedented Guarantee and Warranty

I do all of my own manufacturing in my home state of Minnesota and all materials are 100% made in the U.S.A. I'm so confident MyPillow will help you, I'm offering an unprecedented 60-day money back guarantee and a 10-year warranty not to go flat! I truly believe MyPillow is the best pillow in the world and that if everyone had one, they would get better sleep and the world would be a much happier place.

Michael J. Lindell

Michael J. Lindell
CEO, MyPillow, Inc.

Get the Sleep You've Been Dreaming About

Save 50% today when you use promo code: "popular2"

BUY NOW AT: mypillow.com OR call 800.299.4017



ENGINEERING

REPORTED BY ELISIA GUERENA + LOIS PARSHLEY

U.S. Department of Energy's Pacific
Northwest National Laboratory

RICE THAT FIGHTS GLOBAL WARMING

More than half the global population relies on rice as a regular part of their diet. But rice paddies have a downside for the planet too: They produce as much as 17 percent of the world's total methane emissions. So Christer Jansson, a plant biochemist at the Pacific Northwest National Laboratory, spent the past 10 years developing SUSIBA2, a genetically modified rice plant that emits almost no methane. Splicing a single barley gene into common rice, his team found, changed the way the plant handles photosynthesis: Instead of sending carbon to the roots, to feed the bacteria that produce methane, the plant directs it toward the grain and leaves, increasing the starch level and yield. "It's a win-win," says Jansson. The rice performed well in field tests in China, and now scientists are studying how cultivation affects it. Jansson says there's no telling when the rice might be commercially available, but considering how severely methane can accelerate climate change, its eventual impact could be huge.





Wind+Wing Technologies

A Fuel-Free Commuter Ferry

The average high-speed ferry burns through more than 5,000 gallons of fuel per day. The one built by Wind+Wing Technologies typically harnesses 10,000 pounds of wind power instead. Three microphones send data to a computer that determines the wind's direction. A carbon-fiber sail then pivots around a 75-foot spine to capture it. All electronics—the wind sensor, wing controls, GPS, and communication tools—are powered by a 50-watt photovoltaic cell.

University of Washington

A CAMERA POWERED BY WI-FI

To power the expanding Internet of Things, devices will need to scavenge energy. Engineers at the University of Washington devised a camera that can glean energy from ambient Wi-Fi. The trick was modifying standard routers to broadcast when a channel is not being used. That alerts the camera to an open signal which can, in 35 minutes, provide enough power to take a photo. As team member Vamsi Talla says, "This enables a world of battery-free devices that will do their job perpetually."

The Durst Organization, The Port Authority of New York and New Jersey

The Most Secure Skyscraper Ever

At 1,776 feet, One World Trade Center is the tallest skyscraper in the Western Hemisphere. It's also the safest one in the world. With heavily reinforced walls making it impact resistant, it offers unparalleled security through brute strength.



ETH Zurich

YARN MADE FROM SLAUGHTERHOUSE WASTE

Slaughterhouses produce an enormous amount of gelatin as byproduct. By mixing it with protein, water, and organic solvent, Philipp Stossel of Switzerland-based university ETH Zurich found a way to recycle that waste into yarn. The exterior of the individual fibers—approximately half the diameter of human hair—appear lustrous. The pockmarks on the inside, Stossel says, are likely what provides insulation similar to natural fibers like merino wool.

Hiroshima University

The World's Fastest, Strongest, Lightest Temporary Bridge

When natural disasters hit, they often destroy bridges first. So engineers from Hiroshima University in Japan set out to build a quickly built, strong replacement. Inspired by origami, the new mobile bridge spans 56 feet and takes three people less than an hour to deploy. Often no foundation work is needed, making it ideal for areas affected by earthquakes or floods. Made of aluminum alloy and steel, it's lightweight and easy to transport, yet sturdy enough for cars to cross.



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We have invested millions of dollars in our own state-of-the-art quality test labs and millions more in our factories, so our tools will go toe-to-toe with the top professional brands. And we can sell them for a fraction of the price because we cut out the middle man and pass the savings on to you. It's just that simple! Come visit one of our 600 Stores Nationwide.

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Limit 1 coupon per customer per day. Save 20% on any 1 item purchased. *Cannot be used with other discount, coupon or any of the following items or brands: Inside Track Club membership, extended service plan, gift card, open box item, 3 day parking lot sale item, compressors, floor jacks, saw mills, storage cabinets, chests or carts, trenchers, welders, Admiral, CoverPro, Daytona, Diablo, Franklin, Hercules, Holt, Jupiter, Predator, Stik-Tek, StormCat, Union, Vanguard, Viking. Not valid on prior purchases. Non-transferable. Original coupon must be presented. Valid through 3/10/16.

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WITH ANY PURCHASE
PITTSBURGH
**1" x 25 FT.
TAPE
MEASURE**
LOT 69080 shown
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VALUE**

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WOW SUPER COUPON

Customer Rating **★★★★**
**26", 4 DRAWER
TOOL CART**
US • GENERAL
LOT 95659 shown
61634/61952
SAVE \$250
\$999 ~~\$159.99~~ comp at \$349.99
• 580 lb. Capacity

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SUPER COUPON

**27 LED PORTABLE
WORKLIGHT/FLASHLIGHT**
LOT 67227 shown
69567/60566/62532
Customer Rating **★★★★**
SAVE 58%
\$2.99 comp at \$7.15
Batteries included.

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WOW SUPER COUPON

Customer Rating **★★★★**
**12" SLIDING COMPOUND
DOUBLE-BEVEL
MITER SAW WITH
LASER GUIDE**
CHICAGO • PORTLAND
LOT 61776
61969/61970
69684 shown
\$134.99 ~~\$184.99~~ comp at \$399

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SUPER COUPON

**CENTECH
AUTOMATIC
BATTERY FLOAT
CHARGER**
LOT 42292 shown
69594/69955
Customer Rating **★★★★**
SAVE 82%
\$5.99 comp at \$34.99

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SUPER COUPON

**12,000 LB. ELECTRIC WINCH
WITH REMOTE CONTROL AND
AUTOMATIC BRAKE**
BADLAND
LOT 61256/60813
61889/68142 shown
Customer Rating **★★★★**
SAVE \$453
\$299.99 comp at \$752.99

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SUPER COUPON

Customer Rating **★★★★**
**9 PIECE FULLY POLISHED
COMBINATION
WRENCH SETS**
PITTSBURGH
LOT 69043/42304 shown
SAE
METRIC
LOT 42305/69044
YOUR CHOICE \$5.99 comp at \$17.97

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SUPER COUPON

**RAPID PUMP® 3 TON
LOW PROFILE
HEAVY DUTY STEEL
FLOOR JACK**
PITTSBURGH
LOT 61282 shown
68049/62326
62670/61253
Customer Rating **★★★★**
SAVE \$85
\$84.99 ~~\$169.99~~ comp at \$169.99

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WOW SUPER COUPON

**4-1/2" ANGLE GRINDER
drillmaster**
LOT 60625 shown
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Customer Rating **★★★★**
SAVE 62%
\$11.11 ~~\$14.99~~ comp at \$29.97

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SUPER COUPON

**CENTRAL PNEUMATIC
3 GALLON, 100 PSI
OILLESS PANCAKE
AIR COMPRESSOR**
LOT 60637/61615/95275 shown
Customer Rating **★★★★**
SAVE 55%
\$39.99 comp at \$89

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**ADJUSTABLE SHADE
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LOT 61611
46092 shown
Customer Rating **★★★★**
SAVE 50%
\$39.99 comp at \$79.99

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WOW SUPER COUPON

**PREDATOR
GENERATOR
8750 PEAK/
7000 RUNNING WATTS
13 HP (420 CC)
GAS GENERATORS**
LOT 68530/69671 shown
LOT 68525/69677
CALIFORNIA ONLY
76 dB Noise Level
SAVE \$459
\$540 ~~\$589.99~~ comp at \$999

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SUPER COUPON

Customer Rating **★★★★**
MOVER'S DOLLY
HaulMaster
LOT 60497/93888 shown
61899/62399
• 1000 lb. Capacity
\$8.99 comp at \$19.97

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Pierre and Marie Curie University

A ROBOT SURVIVOR

Leg injury? No problem. The robot created at Pierre and Marie Curie University in Paris can overcome disabilities in about two minutes. An algorithm, aptly named Intelligent Trial and Error, enables the robot to discover new behaviors, says lead roboticist Jean-Baptiste Mouret, "basic survival skills" that enable it to operate when damaged. Such a capability could one day lead to robots that work for long periods independently, such as search-and-rescue missions.



Arizona State University

A LASER SO PURE, IT'S WHITE

Lasers have been around for years, but never before have they been capable of emitting pure white light. Researchers at Arizona State University created a nanoscale semiconductor that combines red, green, and blue light (usually lasers emit just one wavelength) to produce the full visible spectrum, including white. Because lasers are brighter and more energy efficient than LEDs, they could replace today's lighting.



Onyx Solar

A Floor That Can Charge Your Phone

Solar panels are practical, but they're limited up there on the roof. Onyx Solar developed an outdoor photovoltaic flooring that picks up the slack: Solar cells inside the anti-slip glass enable decks, balconies, and walkways to draw energy from the sun. The power can be stored in a battery or, when connected to a building's electrical system, sent straight to outlets. The floor can produce 5.6 watts per square foot (enough to charge a cellphone), supports up to 881 pounds, and comes in more than 1,500 colors.



Surf Snowdonia Wavegarden

The Most Radical Indoor Surf on Earth

Wavegarden, the artificial lagoon at Surf Snowdonia in North Wales, produces hollow waves that travel 490 feet without losing power or shape. (Add another 240 feet of taper, and surfers get an 18-second ride.) A computer-controlled gearless ropeway drive system—similar to those used for ski lifts—pulls a wave foil along the bottom of the pool to create the 6½-foot-tall curls. Surf Snowdonia's managing director, Steve Davies, calls them "the longest man-made surfable waves on the planet."



Siemens

Hydrogen Energy's Green Giant

Massive wind farms require massive systems to capture and store surplus electricity. The "green hydrogen" plant that opened this summer in Mainz, Germany, is larger than any other. Thanks to Siemens's special electrolyzer, the plant can transform up to 6 megawatts of electricity (even from fluctuating sources) and use it to split hydrogen from water. The hydrogen can be stored, then either turned back into electricity or sent to refueling stations to power up to 2,000 fuel-cell vehicles.

Manual

EDITED BY *Sophie Bushwick*

Make Sweet Holiday Music



In 2007, electrical engineer Jay Silver discovered how to turn anything into a musical instrument. While tinkering with an electronic-organ kit, he accidentally spilled lentils on the kit's circuit, which produces musical notes. "As I was trying to dry it out," he says, "I noticed the noise was changing." He realized that touching the device shifted the sound.

The next day, Silver took the circuit to the summer camp where he taught and showed the campers how it worked. When it came in contact with conductive objects, they acted as extensions of the device: Users could touch the object to create different sounds, like pressing the keys on a keyboard. Silver's campers tested it out, making music with everything from apples to bicycles. Later, a co-worker suggested that Silver hook up the circuit to a pencil, since electricity can pass through its graphite core. The result was Drawdio, a pencil that plays "music" when you draw.

Silver published instructions for Drawdio online, and he loves when people use his idea to create something new. With that in mind, *Popular Science* built a caroling candy cane—and so can you. **STEPH YIN**

For tips and photos, visit popsci.com/candymusic.

STATS

Time 2 hours

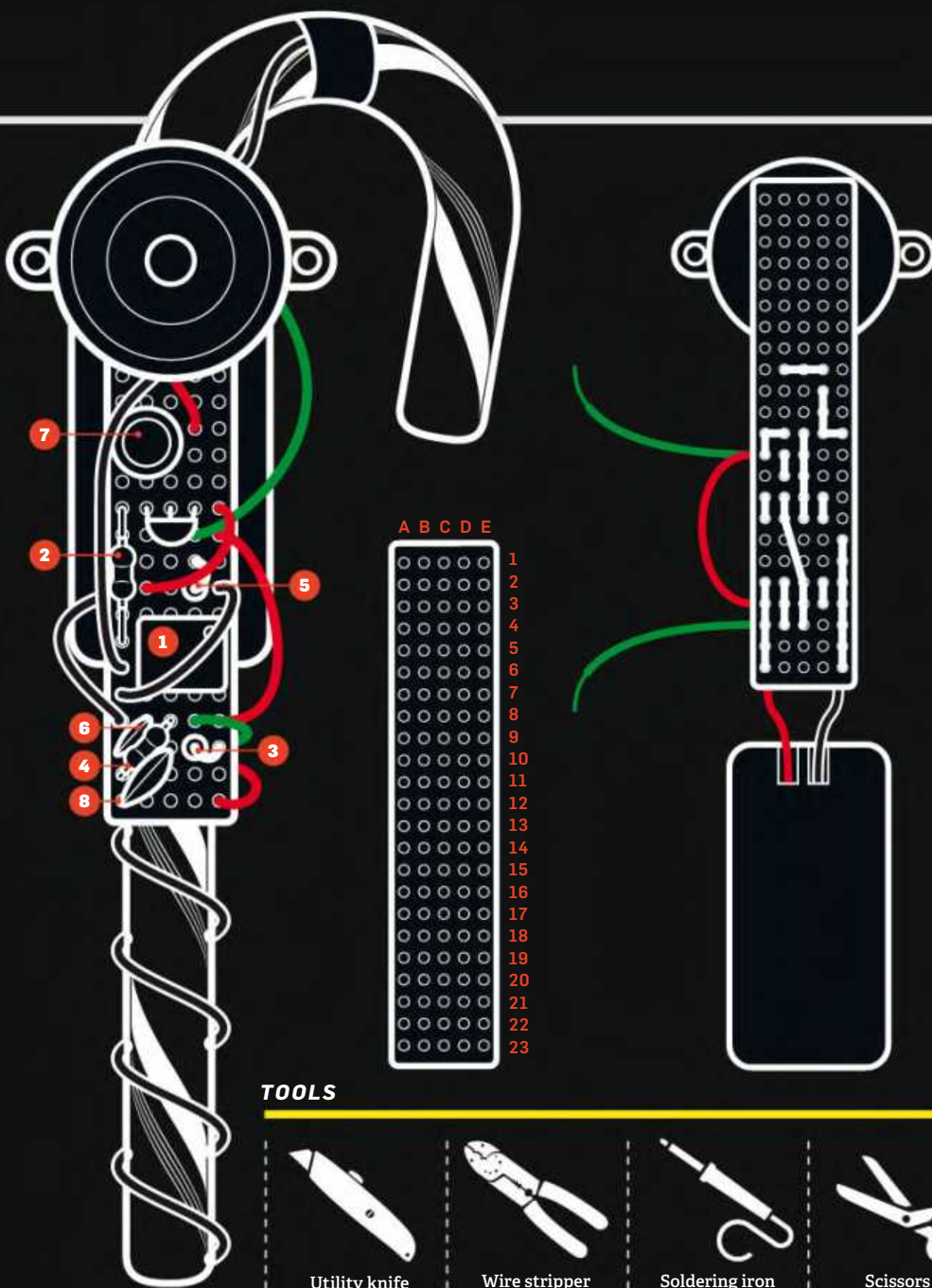
Cost \$55

Difficulty



JINGLE
ALL THE
WAY

WARNING: Don't get milk—or any other liquids—on the circuit or battery.



TOOLS



Utility knife



Wire stripper



Soldering iron



Scissors

MATERIALS

- Perfboard
- TLC555CP LinCMOS timer, eight-pin DIP **1**
- 1/4-watt resistors, 5% (10, 10K,

- 10M, 270K ohm) **2 3 4 5**
- 0.1 uF, 50-volt, 20% ceramic disc capacitor **6**
- 100 uF, 35-volt,

- 20% radial capacitor **7**
- 820 pF ceramic disc capacitor **8**
- PNP general-purpose amplifier, 2N3906

- 22 AWG hook-up wire in red, black, and green
- 2 x AAA battery clip
- Mini speaker with wire leads
- Double-sided

- foam tape
- 2 AAA batteries
- Candy cane
- Aluminum foil
- Electrical tape

INSTRUCTIONS

1 Using a utility knife, cut your perfboard into a rectangle with five rows of 23 holes. Insert the TLC555CP timer with the upper left corner at A16. Bend the timer's legs out underneath the perfboard to keep it in place.

2 Stick the resistors, capacitors, and amplifier in the perfboard as shown. Use jumper wires to connect A12 to D15, A15 to E19, and A13 to A20. You can put a foam block beneath the board to hold the pins.

3 Cut 5 inches of green wire, insert one stripped end into B13, and strip 2 inches from the other end. Cut 8 inches of green wire, insert one stripped end into B20, and strip 5 inches from the other end.

4 Strip and tin the leads of the battery clip. Insert the negative lead into E20 and the positive into A23, leaving an inch of wire between clip and perfboard. Strip and tin the leads of the speaker, and attach to the board as shown.

5 Remove everything from the board except the timer. Solder a jumper between pins 2 and 6. Then insert the other components, except for the speaker, in the same order you did before. Solder their leads together

under the perfboard, as shown.

6 Use double-stick foam tape to attach the speaker to the perfboard. Solder the leads into the circuit.

7 Test your circuit: Insert batteries and touch the exposed green leads with your hands. The speaker should emit a tone that changes pitch based on the resistance between the green leads. In other words, moving your hands should alter the sound.

8 Use double-sided tape to attach the perfboard and battery clip to a candy cane. If you plan to reuse the circuit, just wind electrical tape around the unit to hold it in place.

9 Coil the short green lead up the hook of the candy cane and the long green lead down its body. Wrap a band of aluminum foil around each lead and tape closed. Now you can make music!

10 Grip the candy cane with one hand, touching the wire, and lick from the top. You can also try dipping the candy cane into a mug of hot chocolate, keeping the circuit dry, and drinking from the mug with a straw. Or stick one finger in some water on a saucer, and make patterns in the liquid while holding the candy cane in your other hand.

Prototypes

The Ultimate DIY AI



↓
Engineers Ryan Sipes and Joshua Montgomery wanted their maker-space in Lawrence, Kansas, to be more intuitive. So they borrowed an artificial-intelligence system from other makers and used it to do simple tasks, such as controlling the lights or playing music. Then they realized they could create a better one—and sell it.

After several months, eight versions, and countless 3-D-printed prototypes, the team produced a completely open-source device: Mycroft. Users speak commands to the physical interface, which then controls devices like smart locks or speakers, posts to social media, and performs dozens of other tasks. An Arduino board and Raspberry Pi 2 make up the bulk of the hardware, and the team plans to release its code. As developers add their own functions, Sipes hopes the AI will grow smarter over time—just like its prototypes did. **REBECCA HARRINGTON**

Model 1**FUNCTION BEFORE FORM**

For their first prototype, Sipes and Montgomery focused on making Mycroft functional rather than attractive. The vaguely flower-shaped model looked more like a disembodied eye than an item you'd put on the bedside table—but it worked.

Model 2**RAPID PROTOTYPING**

While this version might look like a regression, Sipes says it's his favorite. He 3-D-printed it when he needed a quick design to test out a software update. Sometimes, he says, you need only a basic template to check if your ideas are good ones.

Model 3**FRIENDLY DESIGN**

When design lead Derick Schweppe joined the team, he created a prototype that resembles a clock radio. The team eventually added a simple LED face inspired by pop-culture robots like Wall-E. "You're much more likely to talk to something that's cute than kind of creepy," Sipes says.

**"Mycroft, fly a perimeter check!"**

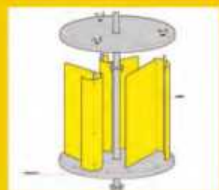
SIPES AND MONTGOMERY PROGRAMMED THEIR DEVICE TO LAUNCH A TOY DRONE WHEN IT HEARS THIS COMMAND.

Current model

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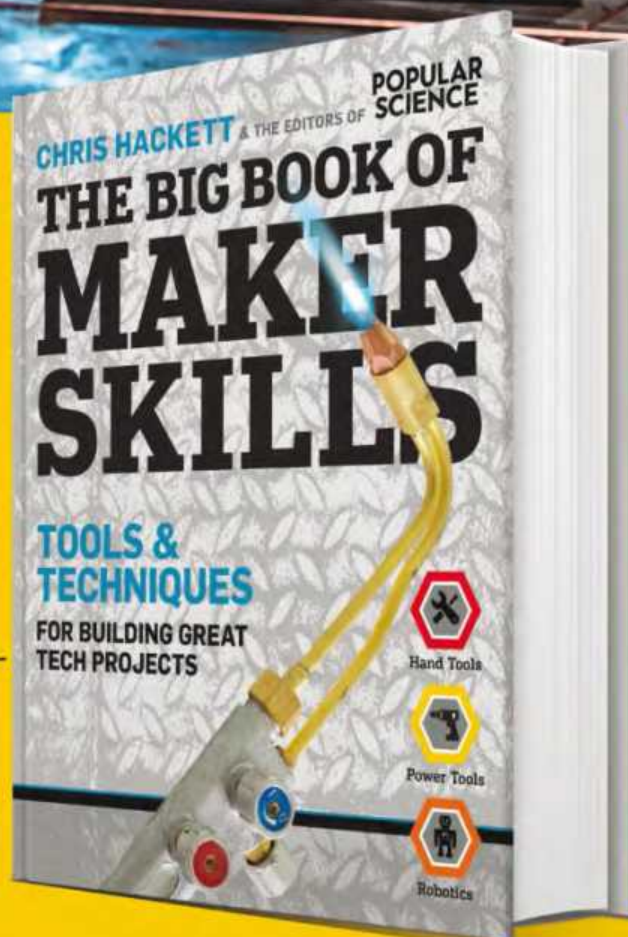


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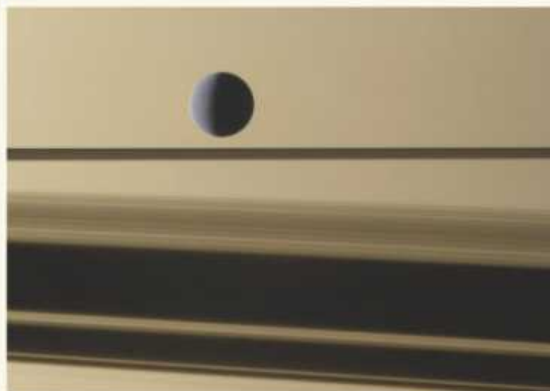
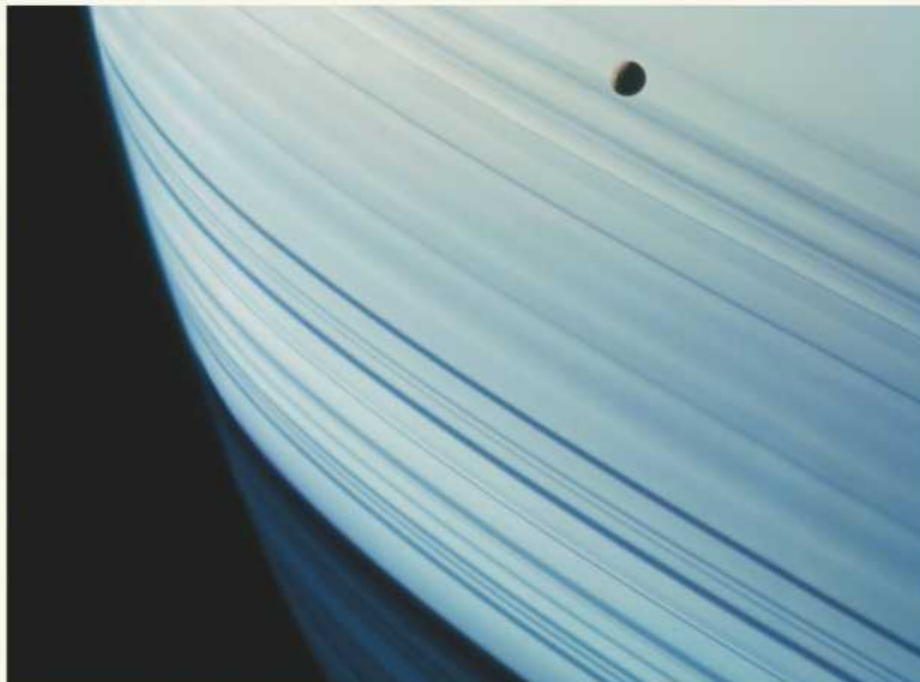
Enviably Project

TURNING
DATA INTO
SPACE ART

Instead of buying photos of our solar system, artist Michael Benson decided to create his own—and to do it better. The longtime space aficionado learned to piece together mosaics by combining hundreds of NASA images into one planetary landscape. Spacecraft typically record in various color filters to see different elements of the same view. By overlaying them, Benson creates a detailed, true-color picture of the COSMOS. SARAH KEARTES

Have you had any “Eureka!” moments during your work?

If I were to choose only one, it would be when I made a color composite mosaic of Saturn's satellite Enceladus. This, to my knowledge, is the first color view of the entire moon in which you can see the geysers of water shooting into space. I sat back, looked at it, and realized with kind of a jolt that I was probably the first person to



Michael Benson

see Enceladus the way it might look if we could actually go there.

Can amateurs also do this?

Anybody can access the raw data and work with it—that's one of the great things about the U.S. space program. There are even online tutorials. I would start with the ones on the Planetary Society site.

Benson used data from the *Cassini* spacecraft to create these images of Saturn's moons Mimas (top) and Rhea (bottom). He included them in his 2012 book *Planetfall*.

What do you hope people take away from your work?

If my work transmits the sense of wonder I feel at the weirdly compelling and even haunting aspects of the solar system—those alien places that we somehow belong to because our world is part of a greater continuity—then it has succeeded.

Tech Support

Q: How do I track a family of rhinos within an exhibit without disturbing them?

—SAFARI THEME-PARK EMPLOYEE



A: Normally with GPS tracking, people want the smallest device possible. But when working with rhinos you run the risk of a 4,000-pound animal crushing it. Instead, you can hollow out a cavity in the rhino's horn and place a GPS logger and battery inside. Rhino horns are made mostly of keratin, the same type of protein that makes up hair and fingernails, so this would provide protected space to stash the electronics without harming the animal. —TIMOTHY HOLMBERG, TECHNICAL SUPPORT MANAGER AT SPARKFUN

AS TOLD TO NICOLE LOU

Cut a Record from a Tortilla



When Dwight Chia, a senior at the University of California at San Diego, saw a YouTube video of a record player spinning a tortilla, he decided to turn the joke into reality. Chia's hobby, creating 78 rpm acrylic records on a laser cutter, served him well. A record stores information as ridges along the length of each groove, and the extra grooves required when spinning at 78 rpm provide more data per second. That speed "turned out to be the key in



getting discernible sound out of a tortilla," he says. Chia's record, made from an uncooked flour tortilla, can play a muffled "Mexican Hat Dance"—and it's edible. **LEVI SHARPE**

TOOLS+MATERIALS

- Paper and tape
- Uncooked flour tortilla at room temperature
- Laser cutter
- Record player

INSTRUCTIONS

1. Download the PDF files for a "Mexican Hat Dance" record from popsci.com/tortillarecord. Or create files for another song using Chia's online instructions.
2. Tape a sheet of paper to the cutting bed to keep it clean. Then position the tortilla and focus the laser cutter.
3. Send each PDF to the laser cutter with the speed set at 95, power at 20, and frequency at 5,000.
4. Cut the outer diameter and spindle hole with the speed set at 20 and power at 100.
5. Place the tortilla on a record player and let it spin!

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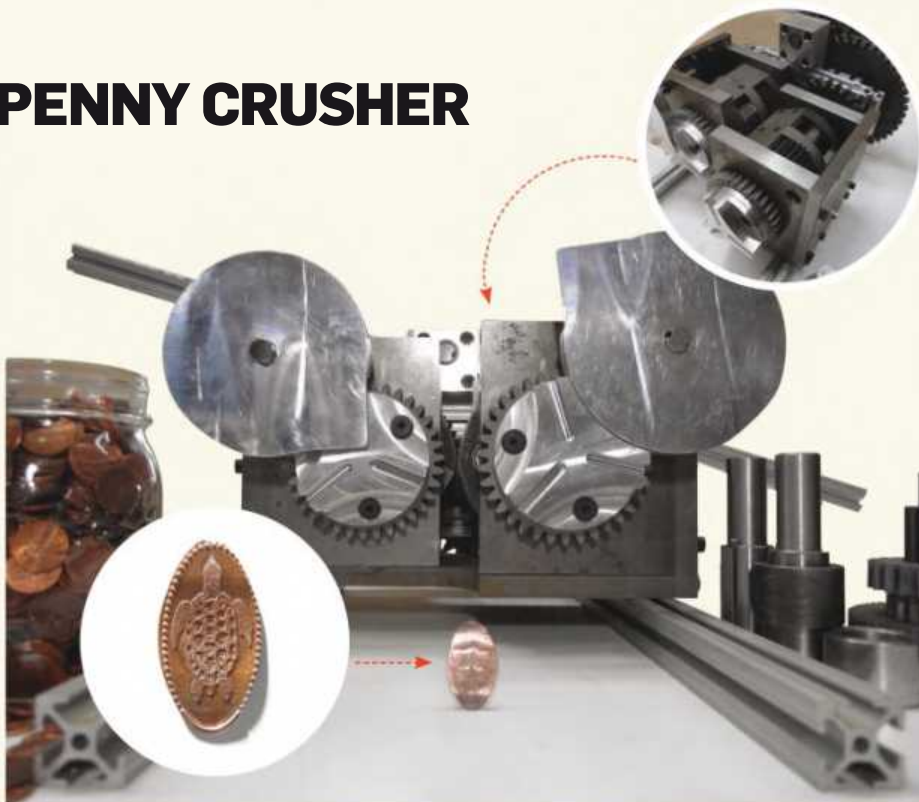
Pennies that would need to be crushed to recoup the \$4,500 cost of the project

STEAMPUNK PENNY CRUSHER

After Stuart Anderson quit his job at Twitter last year, he needed a project to occupy himself. For years, he and sculptor Shaun Slifer, his roommate, had talked about creating a penny crusher—Slifer has collected souvenir pennies since childhood. Anderson decided it was finally time.

Putting his robotics doctorate to good use, Anderson built a metal prototype, then machined the final version. Hand-cranked gears turn two cylinders, each etched with an image. The cylinders drag a penny through the gap between them, flattening and elongating the coin while pressing an image into both sides. Slifer, along with eight other artists, created more than a dozen penny designs, many showcasing critically endangered or extinct animals from North America. "The machine uses technology to speak critically about technology and our relationship with the natural world," Anderson says.

This summer, Anderson and Slifer hope to display the penny crusher at a branch of the Brooklyn Public Library. They joke it might recoup their investment someday—it's currently set up to charge 50 cents per penny. **REBECCA HARRINGTON**



COURTESY STUART ANDERSON; PENNY INSET: JONATHAN KAMBOURIS



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Q: WHY DOES BRIGHT LIGHT MAKE ME SNEEZE?

Short answer

Might be all in your head.

A:

Perhaps as many as a quarter of us sneeze when we look at a bright light, a condition scientists have been calling "photic sneeze reflex" since 1954. But the condition goes back millennia. Aristotle proposed that the sun's heat dries nasal fluid, causing the nose to tingle. (The ancient Greeks also suggested sneezing is divine and should occur only during sexual excitement.) Modern science has put forth a few more likely explanations.

For starters, the effect has been observed in babies, so it's probably not a learned response—but it could be genetic. One Swedish study found that in families where one parent had the condition, more

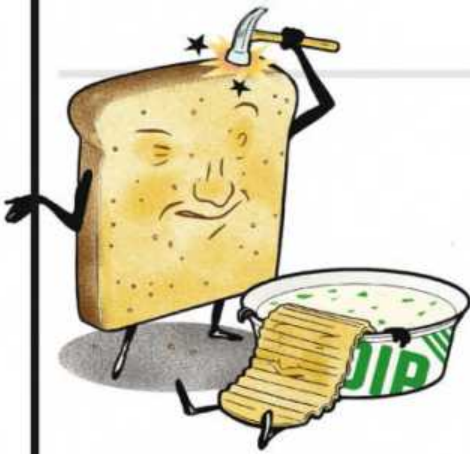
than half of the children had it too. A separate research team even found two places in the human genome where the trait might reside, though they've yet to prove it.

On a mechanistic level, the condition might result from crossed signals in the brain's wiring. Scientists have speculated that intense activation of the optic nerve, such as you'd get from stepping into bright sunlight, could leak into the nearby trigeminal nerve, which responds to nasal irritation—thus triggering the sneeze.

Or the cause might lie elsewhere in the brain. A few years ago, researchers at the University of Zurich recruited 10 photic sneezers and 10 nonphotic sneezers to test another theory. They measured brain waves using electroencephalogram (EEG) while flashing bright lights at their subjects. The photic sneezers displayed more activation in their visual cortices, suggesting that this extra sensitivity to light extends this reflexive process beyond the brainstem.

ASK ANYTHING

DECEMBER 2015



Q: WHY DOES STALE BREAD TURN HARD, BUT STALE CHIPS TURN SOFT?

Short answer A chip is all crust.

A:

In the science of staleness (yes, there is such a science), you have "crust staling" and "crumb staling." Crust staling is the process by which the outside of a loaf of bread goes

from crisp to soft. Crumb staling is when the inside turns hard.

It's easy to explain the first: Crust absorbs moisture from inside the loaf. Potato chips, which absorb moisture from the air, are all crust, so they completely soften.

Crumb staling is more complicated. Over the years, food scientists have published hundreds of papers on the subject. Many have come to believe the process has to do with starch within the gluten structure. "Starch granules exude amylose during baking," says Bill Atwell, professor of grain science at the University of Minnesota. Spiderwebs of amylose then attach to the gluten network. As the crumb sheds moisture, these webs stiffen. Some bread manufacturers extend shelf life by adding enzymes that sever these amylose strands, or by way of additives that inhibit starch from interacting with gluten.

Staleness can also be a state of mind. In a 2004 study, Oxford University researchers asked people to eat Pringles while sitting in a soundproof booth wearing headphones that amplified their munching. When researchers cranked up the crunching, subjects rated the chips as fresher.



Q: DOES IT FEEL BETTER TO GIVE OR RECEIVE A GIFT?

Short answer

It's the thought that counts.

A:

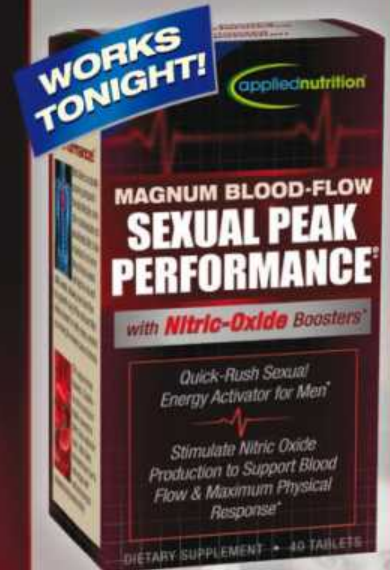
"Spending money on others might represent a more effective route to happiness than spending money on oneself," says Elizabeth Dunn, a University of British Columbia psychologist. In 2008, she conducted a survey of 632 Americans to study their spending habits and happiness. The subjects reported spending a lot more on themselves than on friends or relatives: \$1,714 versus \$146, on average. But their happiness correlated more strongly with the gifts they gave.

Receiving gifts also has a strong effect. A 1998 study led by Charles Areni, now of Macquarie University in Australia, asked 174 college students, half male and half female,

to write down a memorable gift-related experience. The majority, about 71 percent, described receiving a gift. The results were even more pronounced along gender lines: Among females, 92 percent focused on getting versus giving. Among males, it was 55 percent.

Gad Saad, an evolutionary psychologist at Concordia University in Montreal, is not surprised to see gender differences. In the animal kingdom, he observes, the male typically gives food to the female. In a 2003 experiment, in which Saad asked people to explain their gift-giving motives, he found men were more "tactical." They wanted their gifts to convey a message, such as "I'm rich." Women were more likely to gift for reasons like a birthday. 

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By Executive Order and Congress Public Law 99-185, Americans can now buy modern government-issued gold. Congressionally authorized United States gold coins provide American citizens with a way to add physical gold to their assets. Gold American Eagles are made from solid gold mined here in America, minted at the U.S. Mint at West Point, and produced with a U.S. dollar

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want to miss this opportunity. Now is the time to consider converting part of your paper assets into gold coins. U.S. Money Reserve has a limited supply and urges you to make your coin reservations immediately. Call 1-800-308-9452 to start your gold portfolio with U.S. gold coins and begin protecting your wealth today. If you've been waiting to move your money into gold, the time is now.

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* Special offer is strictly limited to only one lifetime purchase of ten coins (regardless of price paid) per household, plus shipping and insurance (\$15-\$35). Prices may be more or less based on current market conditions. The markets for coins are unregulated. Prices can rise or fall and carry some risks. The company is not affiliated with the U.S. Government and the U.S. Mint. Past performance of the coin or the market cannot predict future performance. Price not valid for precious metals dealers. All calls recorded for quality assurance. Offer void where prohibited. Coin dates our choice. 1/10-ounce coins enlarged to show detail.

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Helenite is produced from the heated volcanic rock of Mount St. Helens and the brilliant green creation has captured the eye of jewelry designers worldwide. Today you can wear this massive 6½-carat stunner for **only \$149!**

Make your emeralds jealous.

Our **Helenite Necklace** puts the green stone center stage, with a faceted pear-cut set in .925 sterling silver finished in luxurious gold. The explosive origins of the stone are echoed in the flashes of light that radiate as the piece swings gracefully from its 18" luxurious gold-finished sterling silver chain. Today the volcano sits quiet, but this unique piece of American natural history continues to erupt with gorgeous green fire.

Your satisfaction is guaranteed. Bring home the **Helenite Necklace** and see for yourself. If you are not completely blown away by the rare beauty of this exceptional stone, simply return the necklace within 30 days for a full refund of your purchase price.

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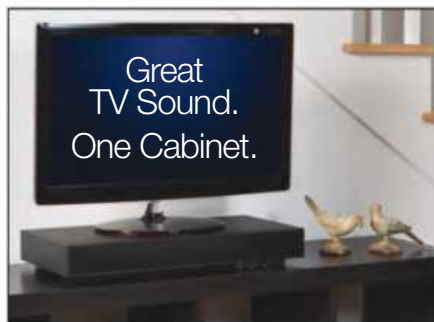
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How to Stash Sunlight



It might seem daunting to build a solar-powered house in Massachusetts instead of, say, Phoenix. But MIT engineers tackled the challenge with a brazen concept, which we featured on our cover in March 1949. The Dover Sun House relied on several vats of Glauber salts, or sodium sulfate, placed throughout the living quarters. (Our illustrator depicted them as a fanciful "heat bin" in the attic.) The salts melt at 90 degrees Fahrenheit and store energy more efficiently than water. The system, devised by chemist Mária Telkes and architect Eleanor Raymond, channeled the sun's warmth to the sodium-sulfate tanks, which meted out heat on cold or overcast days. It worked better in principle than in practice: Tenants were chilly in winter, and the tanks tended to leak. They moved out after a few years. Today, the Tesla Powerwall stores solar energy more effectively with lithium-ion batteries. Turn to page 50 to learn more. **KATIE PEEK**



THREE MORE WAYS TO PACK POWER

In the 28 years that *Popular Science* has been honoring the year's top innovations, several energy-storage solutions have earned Best of What's New awards.

1991 QUICK-CHARGE CAR BATTERY

Developed by Nissan, the battery was touted as a big step forward in electric-car technology because it could be charged in just 15 minutes.

2007 A ROOFTOP ICE BLOCK

The Ice Bear stores energy during the night by freezing a pool of water into a block of ice. During the day, the ice supplies air conditioners with cool refrigerant.

2014 EARTH-FRIENDLY BATTERY STACK

Aquion Energy's modular batteries use a nontoxic, nonflammable solution to store energy from wind and solar: salt water.

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